DECEMBER 1957

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

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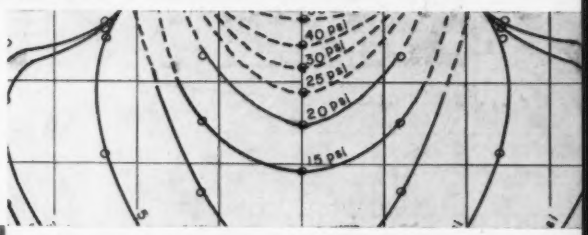

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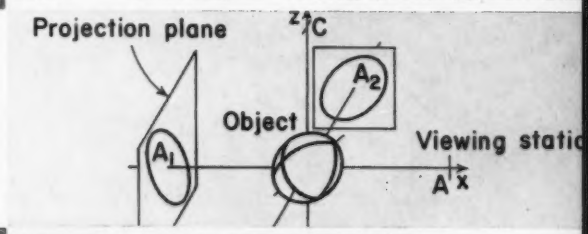

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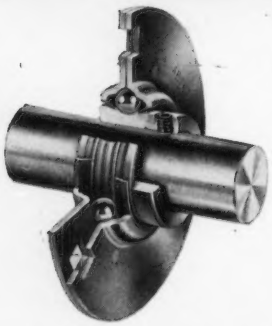
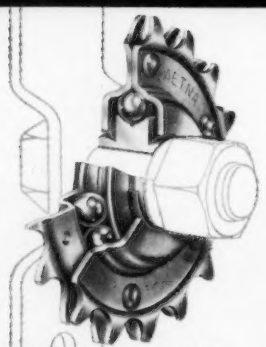
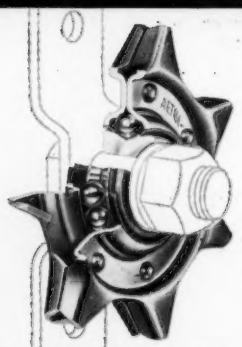
AMERICA'S MOST COMPLETE LINE



ADAPTER UNIT



SPROCKET IDLER UNIT
(Single pitch chain type)



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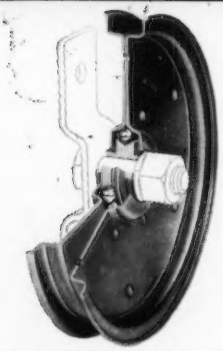
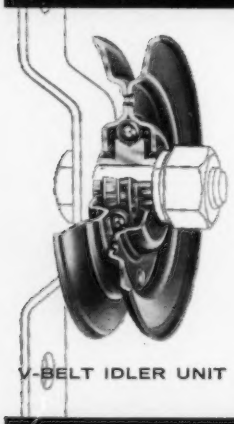
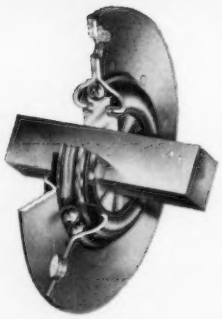


FLAT BELT IDLER UNIT

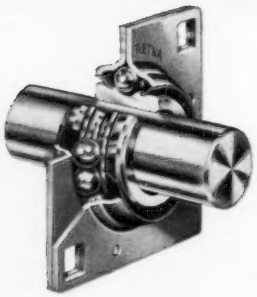
OF LOW-COST, PRE-LUBRICATED



V-BELT IDLER UNIT



DISC HARROW UNIT



GRAIN ELEVATOR UNIT

The Economy Line That Lets You Put MORE Ball Bearing Efficiency to Work in MORE Places

BALL BEARING *Package* UNITS

Designed and built-to-be-installed-and-forgotten these permanently lubricated, sealed-for-life bearing units require no re-lubrication, no maintenance of any kind. Factory assembled, they combine bearing, seals and housing in a single, compact, easy-to-install *package* that saves time on equipment assembly lines—assure longer, trouble-free performance to equipment users.

Catalog AG-57 gives complete specifications. Write for it on your company letterhead—see how, with minimum or no engineering alterations, these inexpensive bearing units can be adapted to your current or projected equipment designs. Aetna Ball and Roller Bearing Company, Division of Parkersburg-Aetna Corporation, 4600 Schubert Avenue, Chicago 39, Illinois.

Aetna

Anti-Friction Consultant to Leading Original Equipment Manufacturers Since 1916

For more facts circle No. 33 on reply card

R B&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

Fastener coatings

Salt spray testing of various metallic coatings used on fasteners doesn't always give a true picture. In actual service, accelerated test results are not always borne out.

Reason: The tests favor the coatings which can endure continuous moisture and salt atmospheres, whereas some do better under the normal intermittent dry and wet conditions of weathering.

Experience has developed a "scale" of suitability of various coatings for fastener protection.

FOR RUST PROTECTION

Hot galvanizing offers greatest endurance under most conditions. It falls short on highly stressed fasteners.

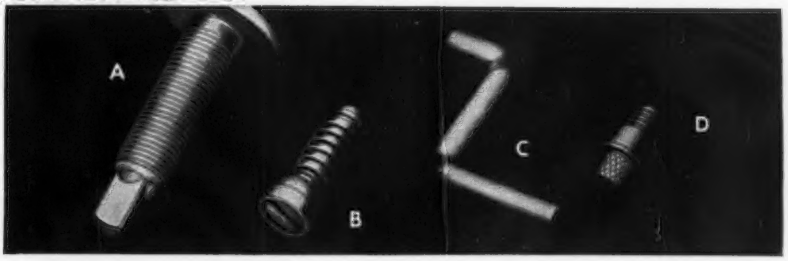
Electrodeposited zinc is next most practical—providing good appearance, controlled tolerance at threads, and ability to take high bolt tensions.

Cadmium plate stands out where salt atmospheres predominate. Not suitable for contact with edibles, it is ruled out for many appliances.

For general applications, the rust prevention of black oxide coatings proves satisfactory. Phosphate coatings, too, offer some degree of protection, but not under severe conditions.

Chromium, plated over copper, should be considered more for its appearance on fasteners rather than protection.

Cold heading creates quality parts the low cost way



No value analysis of product components is really complete without exploring what cold heading machines can do to cut costs. Some examples:

A. ELIMINATE EXTRA OPERATIONS. Leveling screw, formerly made by riveting flat disc to set screw, now emerges as a stronger, single piece from a cold header.

B. ONE PIECE BETTER THAN TWO. Cold headed hose clamp screw has integral flange which, after head is slotted, is forced up to form screwdriver shield. Before, piece was in two parts . . . with screw made on screw machine, and the shield a stamping fitted around head during assembly.

C. FASTER THAN FORGING. Shifter lever is bent into double "L" automatically in bolt header . . . replacing 2-stage forging operation. The header does it at high speed from continuous rod.

D. METAL *FLOWS* TO SHAPE—NO WASTE. No longer cut on screw machine, insert screw for plastic parts costs 40% less. Cold header uses just the amount of metal required. The threading and knurling, too, are done automatically at high speed.

Metal forced to cold flow into shape results not only in savings but also in stronger parts. With uncut flow lines, the piece is better able to withstand stress concentrations.

For an expert opinion on parts you now use, check with Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

12-point fasteners cut wrench clearance space

Double hex RB&W bolts and nuts measure smaller across their points than single hex fasteners. Used with an *external* socket wrench, they permit optimum driving torque to be applied.

Thus, while permitting design of more compact assemblies, these fasteners also assure proper preloading for stronger connections.

Available with plain flange, or SPIN-LOCK design which incorporates teeth that embed upon tightening and resist loosening under vibration or temperature changes.

For more facts circle No. 2 on reply card

Agricultural Engineering

Established 1920

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JAMES BASSELMAN, *Editor and Publisher*

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Honored As Charter Member

THE Council of the American Society of Agricultural Engineers recently corrected an oversight of long standing when it voted to recognize Elmer W. Hamilton as a charter member of ASAE. This action followed the uncovering of supporting evidence by the committee on ASAE history indicating that Mr. Hamilton personally attended the organizational meeting of the Society in December, 1907.

The committee learned through a search of old records and correspondence with Charles A. Ocock and other charter members that two E. W. Hamiltons attended the first meeting in 1907 at Madison, Wis.—Everett W. Hamilton of the agricultural engineering dept. at Iowa State College and Elmer W. Hamilton, editor of the *Canadian Thresherman*, Winnipeg, Manitoba. When the roster was made up from registration cards of those in attendance it was apparently thought that the two E. W. Hamiltons were one and the same person, and one card was inadvertently destroyed. Therefore, the name of Elmer W. Hamilton was omitted from the list of charter members. Since no record of membership had been made for Elmer W. Hamilton, he joined ASAE again in the Spring of 1908.

ELMER W. HAMILTON

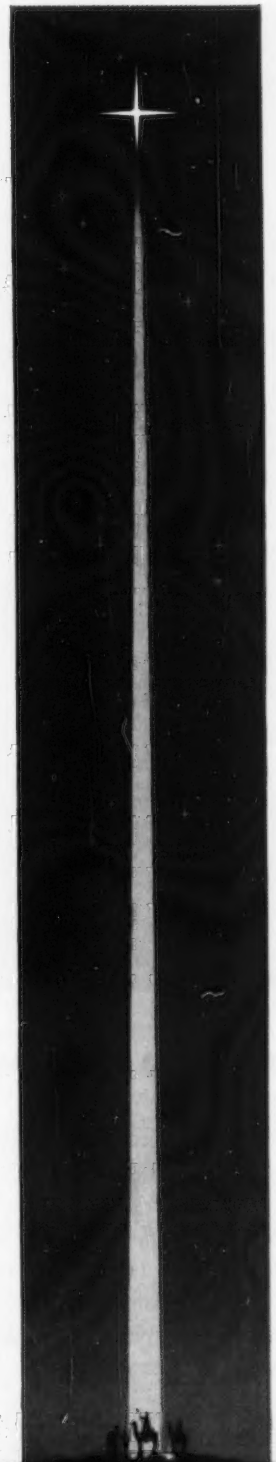
Mr. Hamilton was born in 1879 and raised on a farm near Arena, Wis. He graduated from the University of Wisconsin in 1904 with a B.A. degree. Following graduation he became editor of the *Canadian Thresherman* in Winnipeg, Canada. He inaugurated the Winnipeg Motor Contests in 1908 which were held each July through 1912 to provide an opportunity for tractor manufacturers and agricultural engineers to study the possibilities of the gas tractor as a mobile mechanical power in the field and on the belt. The contests made gas tractor history as both steam and gas were given the opportunity to work side by side under the same conditions.

In 1924 he sold his publishing business in Canada and returned to Madison, Wis., where he was associated with Bascom B. Clarke in publishing the *American Thresherman* and *Gas Review*. He joined Allis-Chalmers Mfg. Co., Milwaukee, Wis., in 1939, to work on the study of grasses, particularly as they pertained to hay and grass silage, and to follow the development of mechanized forage handling equipment. For several years he traveled throughout the United States and Canada observing the grasses and the development of mechanized grass handling equipment in different sections of the two countries. He retired from Allis-Chalmers in 1956 and since that time has devoted his time to the writing of a book, entitled "Man and Grass."

Mr. Hamilton served as treasurer of the Society in 1910. In 1941 he was one of the founders of the Joint Committee on Grassland Farming and served on its executive board for several years. He was made a Life Member in 1945 and elected to the grade of Fellow of ASAE in 1955.

During the special business meeting, Tuesday afternoon, December 17, at the Winter Meeting in Chicago, Mr. Hamilton will be presented as a charter member of ASAE, a recognition 50 years overdue.

One Moment, Wise Men...



One moment, Wise Men . . .
I'd have a word with you.

This journey that you undertake—
I know its secrets, every one.

I know the star you chase,
The gifts you bear,
And Whom it is you seek.

Believe me, Wise Men . . .
I wish I rode beside you,
But since I cannot,
I ask of you this favor—
Pray, take my gift along.

'Tis a humbler gift by far,
Than the very least of yours—
A poor vessel,
Formed of common clay
And much the worse for lack of use.

But notice, Wise Men . . .
The fullness of it now!
Brimful, it is,
Of a rare and priceless compound
No magician can concoct . . .
Of a mixture, brewed in heaven,
That all the wealth of ages
Cannot buy.

So, Wise Men . . .
I beg you, take my gift . . .
Offer it with all the treasures of your own,
And as you offer it,
Recite for me this greeting:

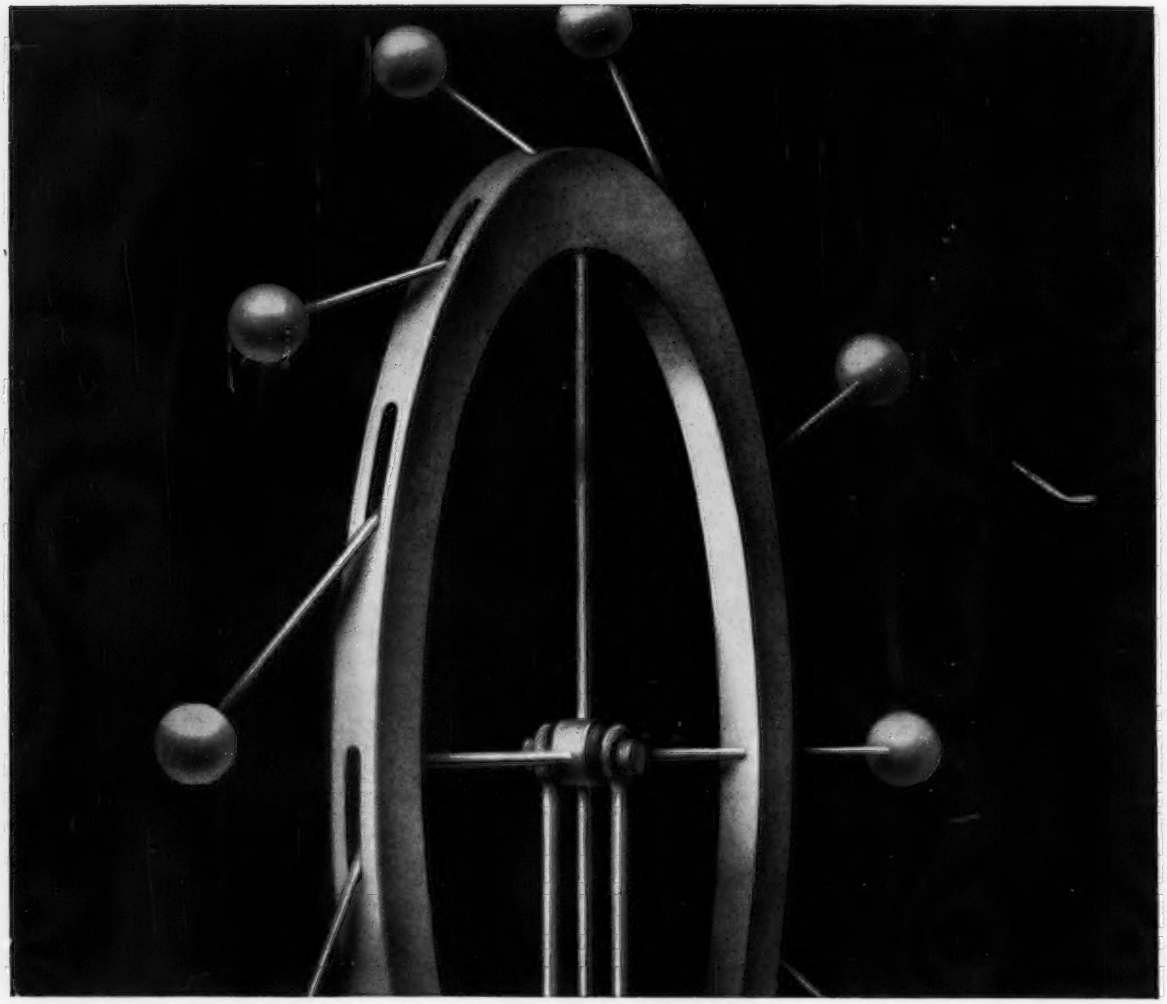
"Here, King, is a beggar's gift,
An earthen vessel . . . crude, misshapen,
And of meager worth at best.

"Still . . . it's all I have to give,
And, bidding You accept it, King,
I send You this . . . ,

An overflowing heart!"

Copyright, John Deere
Moline, Illinois

JOHN DEERE MOLINE, ILLINOIS



what ever happened to perpetual motion?

Nobody's ever solved it, and maybe they never will. Complete elimination of friction and wear are seemingly impossible obstacles.

But industry *has* developed machinery that will virtually run forever. The hermetically sealed unit in your refrigerator, for instance. And even equipment that is not sealed – provided that wear-producing foreign elements can be kept out.

Keeping them out is Purolator's business. Our engineers are constantly concerned with improving performance and lengthening life of industrial machinery and consumer goods. We've learned how to filter impurities from toothpaste, water from jet fuel, even sub-micronic particles from air.

Our research, engineering know-how, quality control and manufacturing facilities – developed through three decades of operation in the entire range of filtration – make up an unmatched experience in the business of taking undesirable contaminants out of liquids, gases and paste.

If you are interested in fighting friction and wear, or improving the performance or quality of your product, this experience of Purolator's is yours for the asking.

FILTRATION FOR EVERY KNOWN FLUID

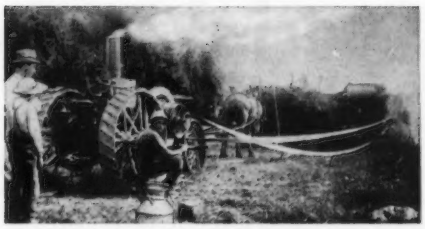
PUROLATOR

PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

For more facts circle No. 3 on reply card

The belt drive p. t. o. stood still . . .



An early-day tractor—International Harvester.

Minneapolis-Moline built this one.

until the splined shaft p. t. o. took over . . .

A late model Allis-Chalmers.

. . . providing flexible power transmission to all implements equipped with adaptable

BLOOD BROTHERS Jointed Drive Lines

History was made when engineers first replaced the "pulley p.t.o." with the universal-jointed shaft. For this concept of flexible power transmission was the key to Progress. Implements that had, until then, remained stationary in the fields now moved forward. And the whole implement industry moved forward too—building innumerable new, better machines driven through universally adaptable, flexible drive line assemblies. Working with the manufacturers, Blood Brothers has kept pace—by building stronger, better drive lines for every farm implement requirement. If *you* build implements, consult Blood Brothers for helpful cooperation.

FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED

BLOOD BROTHERS MACHINE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

For more facts circle No. 4 on reply card

Special Dayton Cog-Belts*

Perform 'Human' Tasks on TAWCO Radish Combine

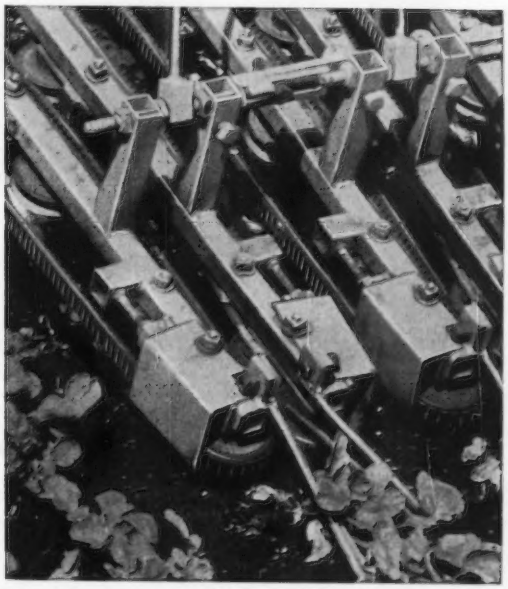
Dayton Agricultural Engineers—working with designers on the Tawco Implement Company's Radish Combine—put V-Belts to an unusual task on this remarkable implement.

The special V-Belt they designed—a long Double Cog-Belt* featuring an extra outer layer of very soft rubber—is used to pick radishes and convey them rearward to a topping assembly.

This extraordinarily efficient Radish Combine, introduced by Tawco over two years ago, has replaced hand picking and harvesting and, for the first time, makes *complete* mechanized harvesting practical. Depending on the size of the radishes, the Tawco Combine—operated by one man—harvests and tops 10 to 15 tons a day.

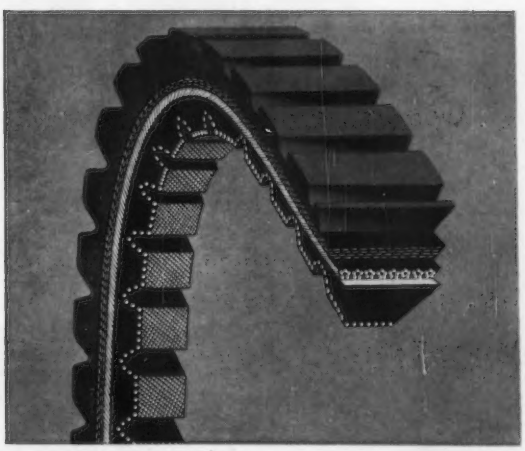
The unique soft-rubber outer section of the specially-built Dayton Double Cog-Belt permits the Combine to perform 100% harvesting with a deft "human touch," without cutting or bruising the radishes. The radish top is grasped between pairs of moving V-Belts, gently lifted from the soil and conveyed to the topping assembly. The inner section of each belt is of conventional Dayton cog construction—noted for easy flexing around sub-diameter pulleys and the ability to clear sheaves of field mud and debris. The success of this special V-Belt design has been proved by field experience with over 200 Tawco Radish Combines.

This is an interesting example of Dayton Field Engineers working hand-in-hand with implement manufacturers in creating efficient agricultural machinery. Consult the Dayton Agricultural Engineer on your drive designs; Dayton's long experience in V-Belt development is at your service. Write The Dayton Rubber Company, Agricultural O.E.M. Division, Dayton 1, Ohio.



When harvesting, each pair of Dayton Double Cog-Belts must grip the top of the radish, lift it from the soil and convey it upwards to the topping mechanism. Soft rubber is used on the conveyor side of the belt to avoid nipping the tender leaves while conventional Cog construction is used on the drive side for maximum durability.

Especially designed for use with small diameter pulleys, Dayton Double Cog-Belts are noted for their ability to clear mud and debris from the sheave groove. Double Cog-Belts are available in standard and special constructions and are generally recommended for use in heavy duty variable speed drives.



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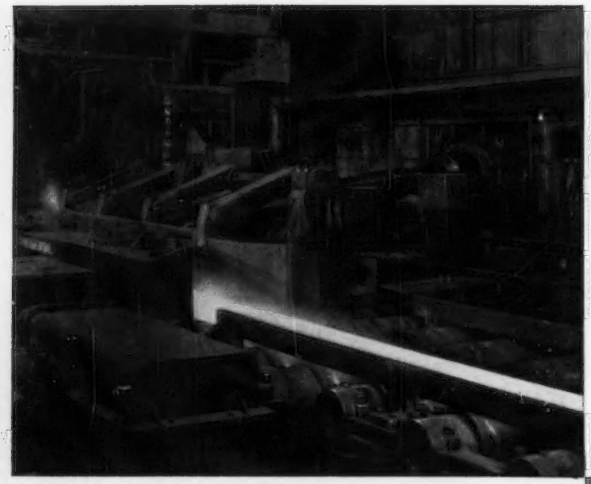
Dayton Rubber

WORLD'S LARGEST MANUFACTURER OF V-BELTS

Agricultural Sales Engineers in Atlanta, Chicago, Cleveland, Dallas, Dayton, Moline, New York, San Francisco and St. Louis



THE HEAVIER THE LOAD...

the more you need HYATTS . . . because for sheer load-carrying capacity in continuous service, straight cylindrical roller bearings have no equal. That's why leading steel mills use HYATT Hy-Rolls for dependability.

THE HIGHER THE SPEED...

the more you need HYATTS . . . because they're built with superior steels, scrupulous control of internal clearances and uncompromising inspections to assure smoother running, even at RPM's required in jet engines.

THE MORE YOU NEED *Cylindrical* HY-ROLL BEARINGS

More and more, as loads and speeds edge upward and housings must often be reduced in size, design engineers are turning to HYATTS to help squeeze improved life/load ratings into limited space. Quality-built HYATT Hy-Rolls not only solve the problem of increased radial loads, but the shouldered-race types will take a surprising amount of thrust as well. Ask your nearest HYATT Sales Engineer for recommendations—he can be a mighty big help to you! Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.; Pittsburgh; Detroit; Chicago; and Oakland, California.

THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

GM FORWARD FROM FIFTY

HYATT HY-ROLL BEARINGS

THE "WORKHORSES" OF MODERN INDUSTRY

 For more facts circle No. 5 on reply card

Report to Readers . . .

NEW TRACTOR DEVELOPS MORE PULL POWER WITH THE SAME HORSEPOWER

The record of the evolution of the internal-combustion tractor comprises a long list of impressive engineering developments and improvements, in which farm equipment industry engineers can take a great deal of pride. One of the more recent developments that seems to us especially outstanding is the one featured in the new Case 800 tractor, into which engineers have designed a combination of torque converter and standard multiple-geared transmission. This new drive provides 8 forward working ranges, and the torque converter operates automatically within each working range. A load can be increased until the tractor is slowed to a standstill, but the engine does not stall. The operator simply shifts to a lower working range and the tractor moves ahead. The big advantage of the torque-converter drive is the tremendous reserve of actual pulling power of the tractor, in the higher gear ranges.

MANURE SPREADER DOUBLES AS SELF-UNLOADING FORAGE WAGON

Since the surge of mechanization in agriculture means a rapid increase in the number and variety of units of operating equipment that will be offered the farm market, the problem of equipment selection is certain to become increasingly difficult. Farm purchasers will be especially interested in items of equipment that have more than a single application, and engineers in manufacturing organizations will be giving more and more thought to the possibility of devising multiple uses for units of equipment they develop. . . . An example of what we are thinking about is the self-unloading forage-box attachment which one manufacturer (Deere) has developed for use on one model of a power-take-off manure spreader. The result of this combination is that the duty of the spreader is doubled at a cost less than half that of a single-purpose forage wagon. This outfit permits unloading chopped material from the side into feed bunks and from the side or rear into blowers, elevator hoppers, and trench and bunker silos.

HIGH-FREQUENCY LIGHTING SYSTEM MULTIPLIES PLANT GROWTH RATE

Speeding up the cyclic processes in plant production, so that botanists may produce several generations of plants per year to expedite plant breeding research, has been made possible by a system of high-frequency fluorescent lighting developed by engineers on the agricultural engineering staff of the South Carolina Agricultural Experiment Station. One advantage of this system is that it creates greater light output per lamp and reduces heating in the lighted area; in a room 6x9x9 feet, it produced 2300 foot-candles of light intensity. A major disadvantage of the system is the high initial cost of frequency-converting machinery.

EMPHASIS ON HIGH SPEEDS DOES NOT APPLY TO THE CORN PICKER

In just about every mechanical operation these days - on the farm, in the factory, on the road, in the air, or wherever - the general trend is toward ever higher speeds. By and large, this trend is sound, but in the case of the mechanical corn picker it appears not to be. One of the engineers in the agricultural engineering department at the University of Minnesota has been telling farmers this past fall that, among the things they can control at corn picking time, ground speed is the most important. He says there would be less corn lost from ear dropping if corn pickers were operated at slower speeds. Ear dropping can result from a number of contributing factors, but none that cannot be overcome to a considerable extent by operating the pickers at slower speeds. . . . Our Minnesota engineer adds that losses from ear dropping may also result from other causes, including varietal differences, soundness of ears, position of gathering points and chains on the picker, position of the snapping rolls, and not driving the picker exactly down the row.

ENGINEERING TITLE STANDARD PROPOSED

We think a policy statement concerning engineering titles adopted in October by the board of directors of the National Society of Professional Engineers really makes sense. As the statement points out, in labor cases, administrative rulings, classification systems, etc., there have been repeated examples of conferring engineering titles on individuals or groups who are not qualified professionally by any acceptable standards of law or engineering practice. As engineers in general well know, engineering titles or designations have been given to employees associated with an engineering department or activity, who are clearly not engineers in a professional sense. . . . NSPE believes that adequate standards now exist through accepted definitions of laws, as well as accredited collegiate curriculums, and it therefore suggests the following standards as the only basis on which any title or designation should include an engineering reference: (1) registration as a professional engineer or engineer-in-training under a state registration law, (2) graduation from an accredited engineering curriculum leading to a bachelor's degree, and (3) an official ruling designating an individual or a group in an engineering capacity as meeting the definition of "professional employee" under the Taft-Hartley Act or the Fair Labor Standards Act. It is not the intent of this proposed policy, however, to prohibit titles such as "engineering assistant" or "engineering aide" when the title clearly implies that the position is of a subprofessional nature.

TILT-UP CONCRETE CONSTRUCTION FOR BUILDING FARM STRUCTURES

This type of construction, casting concrete walls in panels on a level surface, and then, after curing, tilting them to a vertical position and fastening them together with concrete columns, has been in successful use by industrial builders for several years. But in spite of its low-cost advantage, its use in farm construction has been slow to develop. However, some three years ago engineers at the Texas Agricultural Experiment Station set up a research program to study, test, and perfect this type of construction for application to farm buildings. This study, recently completed, now shows that it is possible to build single-story buildings - cattle and machine sheds, loose-housing dairy barns, and such - rapidly and economically by this method.

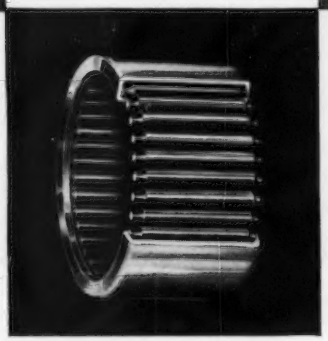
CUSTOM APPLICATION OF FERTILIZER GAINS FAVOR

In certain areas of high-value row crops, farmers are finding custom application a fast and economical answer to getting commercial fertilizers applied to their land. With this system, bulk fertilizer is delivered to a railway siding or truck delivery station, and from there it is loaded on applicator trucks and delivered and applied as desired by the growers. Applicator trucks are equipped with bunk-type hoppers from which the fertilizer is carried to a distributor mechanism at the back of the truck by a conveyor belt running along the bed.

LETS GRAVITY HELP IN PIG FARROWING

Occasionally in scrutinizing the endless procession of great and near-great technical achievements, just in our own engineering back yard, we are sometimes amazed, and delighted too, when we see some alert-minded individual all at once hit upon an idea that is both simple and practical, and when put to work develops into a useful and profitable small business for the originator. It is a refreshing experience that keeps us reminded of the simple but important fact that no such thing exists as a monopoly of good ideas, especially the less dramatic and commonplace ones. . . . We're thinking just now of the Maryland farmer that "Farm Journal" tells about. He thought up a simple, crushproof farrowing crate that uses the force of gravity to help each newly farrowed pig to roll, slide or just amble down a short ramp to a lamp-heated box. The device is both simple and safe for sow and pigs; and now the inventor has patented it and is tooled up and producing the hardware for it for neighbors and other purchasers.

Torrington Needle Bearings save space, save weight, simplify assembly, reduce maintenance, ease lubrication, reduce friction and reduce cost in the Bolens Ride-a-matic garden tractor, manufactured by Bolens Products Division, Food Machinery and Chemical Corporation.



Needle Bearings keep it trim

Small in scale, big in performance—that's the Bolens Ride-a-matic garden tractor. One of the features that helps trim its weight and size and improve performance is the extensive use of Torrington Needle Bearings in the power train.

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How Armco Stainless Steel Provides BALANCED DESIGN in Turkey Waterers

Turkey waterers are often subjected to highly corrosive chemicals that are either present in the water or added to benefit the birds. The chemicals attack the inner liner and trough, causing early failure of these parts.

This is why one large manufacturer of poultry equipment provides inner liners and troughs made of Armco Stainless Steel as optional equipment on turkey waterers for growers who have the problem of chemical corrosion.

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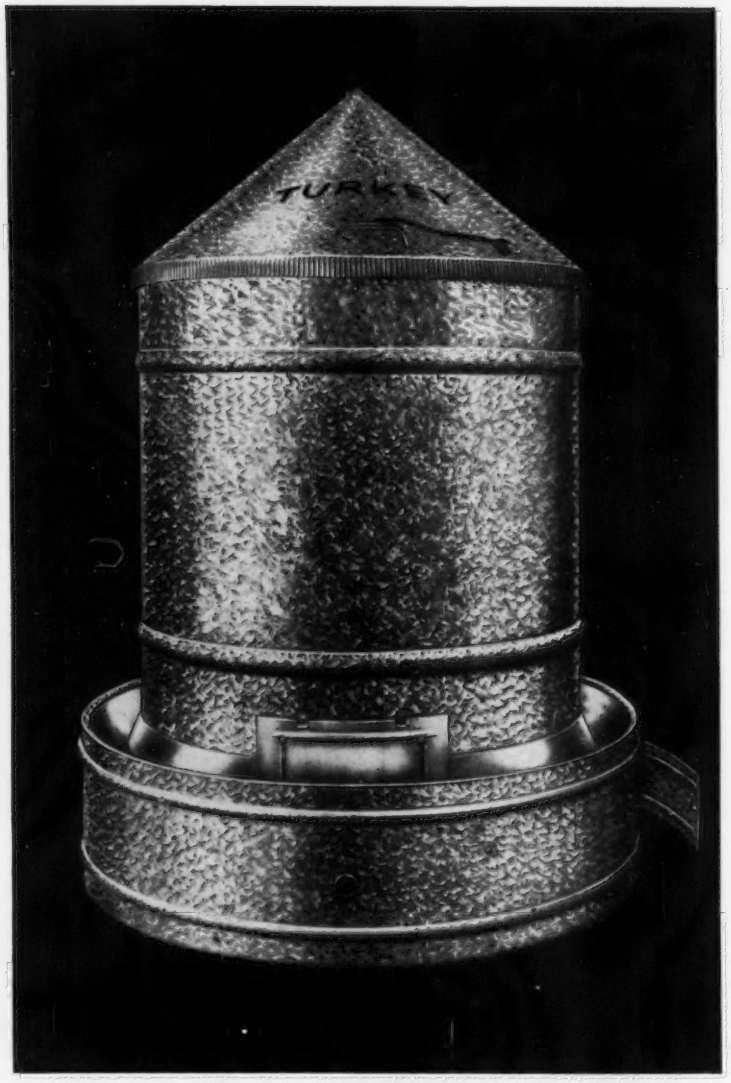
Write us at the address below about your design problems. Our engineers will gladly consult with you on the long range economy of Armco Stainless Steel.



Turkey waterer inner liners and troughs made of Armco Stainless Steel provide balanced design, extend service life of the entire unit.

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While the potential flood *is* still a trickle, the farmer needs strong terraces, dams, diversion channels. Caterpillar equipment — tractors, scrapers, bulldozers and motor graders — are the tools that can stop the floods before they start. These are the machines that will implement the watershed program — will hold the rain in check — will keep the soil home on the farm.

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FREE BOOKLET — "Stop your floods before they start . . ." Write Dept. AE127, Caterpillar Tractor Co., Peoria, Ill.

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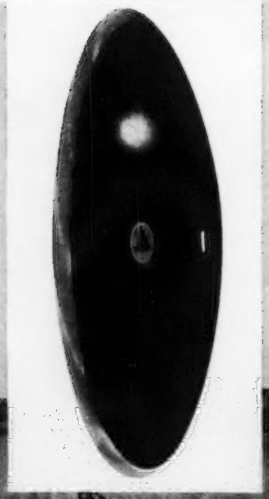

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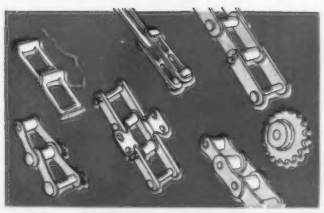

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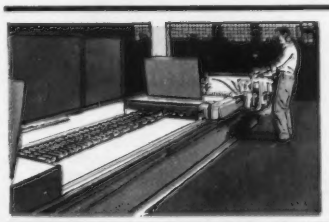

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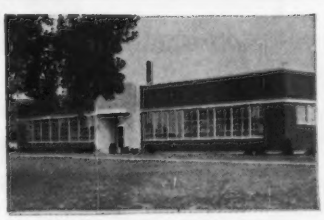

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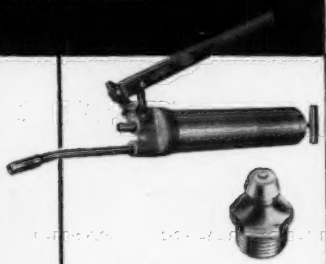

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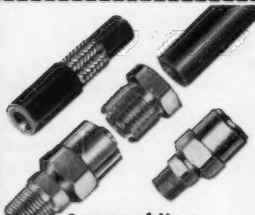

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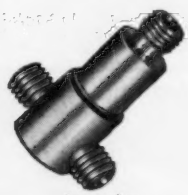

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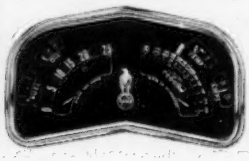

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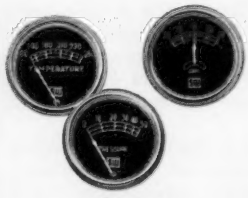

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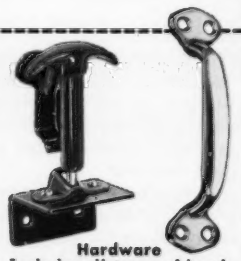

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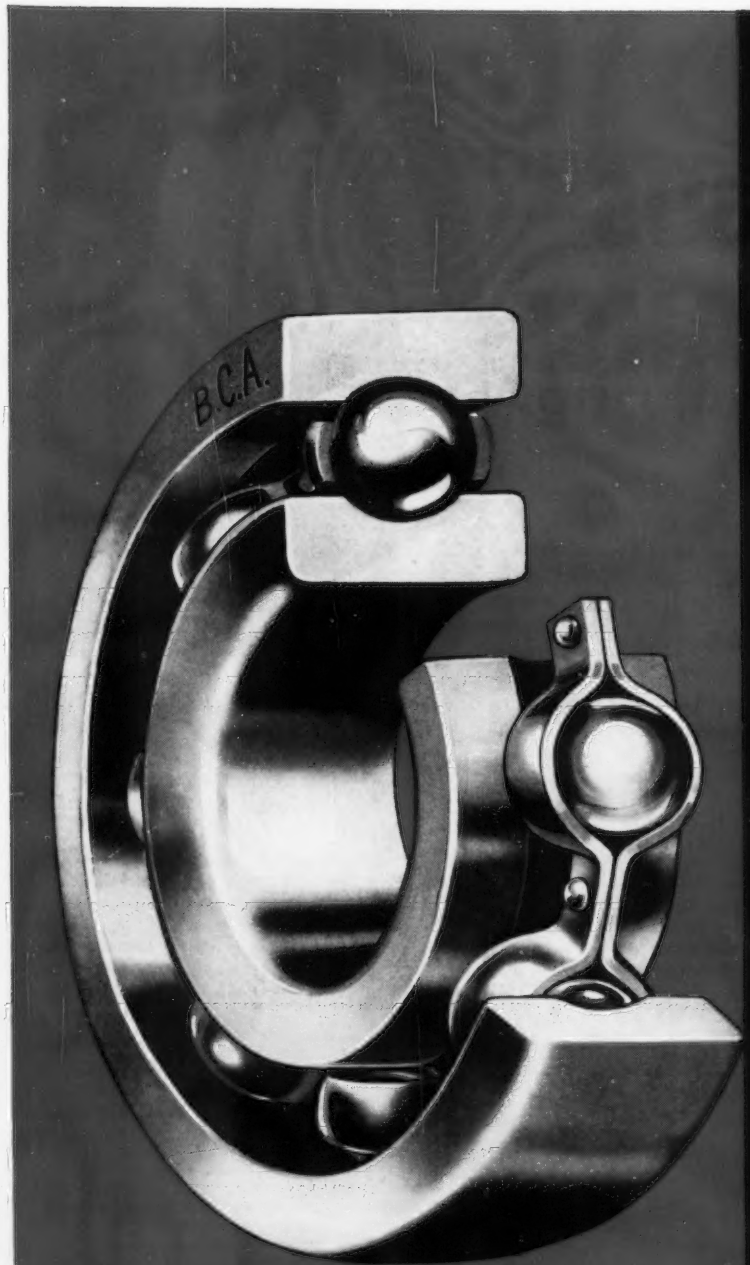

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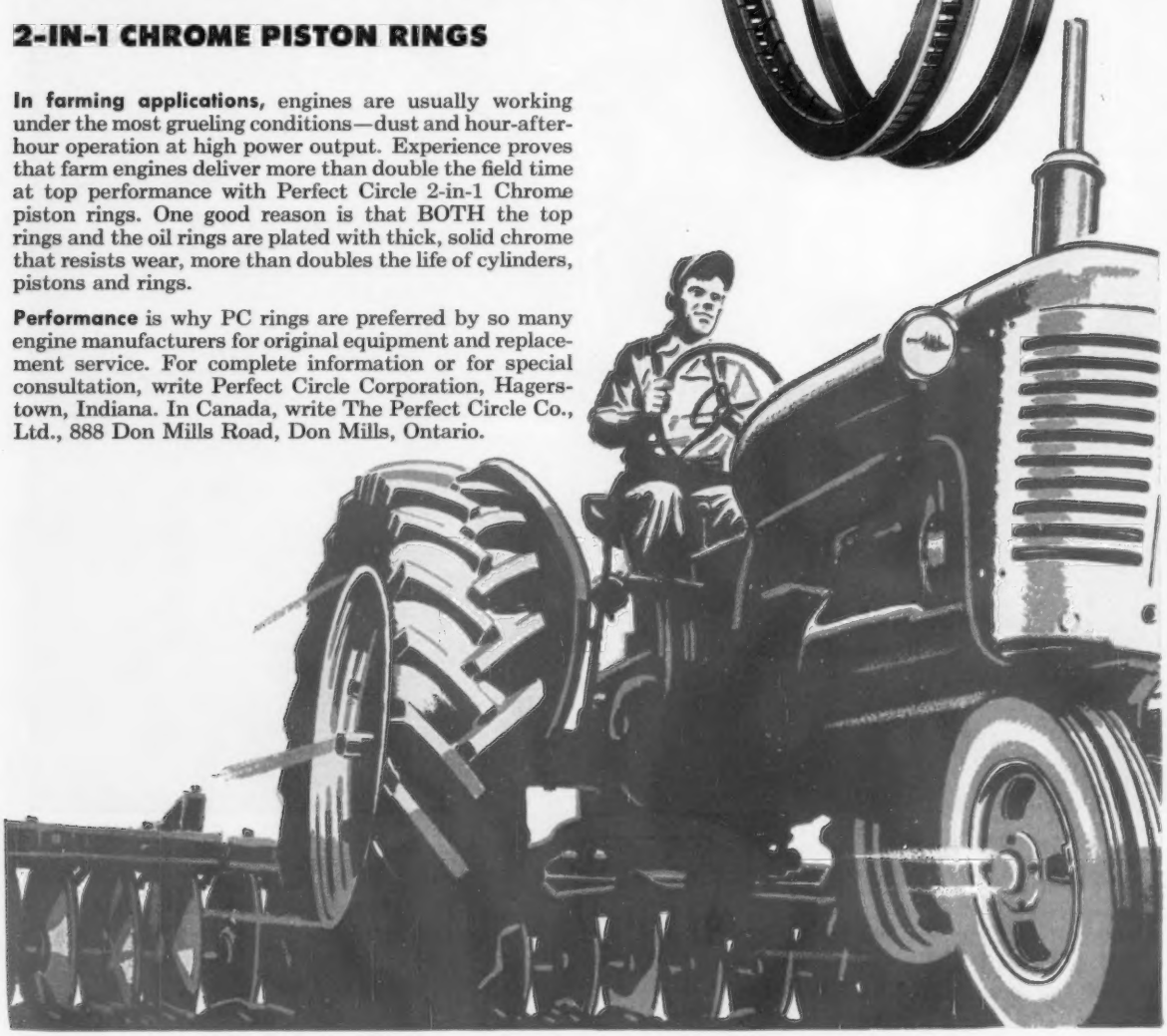

852 For more facts circle No. 13 on reply card

Agricultural Engineering

December 1957
Number 12
Volume 38

James Basselman, *Editor*

Impact of Nuclear Engineering on Agricultural Engineering

John E. Nicholas
Fellow ASAE

THE controlled release of nuclear energy was a stupendous accomplishment. A great deal of work has already been done by physicists and nuclear engineers in directing atomic energy to industrial applications. To increase the store of knowledge on the need and effectiveness of atomic energy in the ramified fields of agriculture and its related industry should be a challenge to the modern agricultural engineer.

Radiation, as now understood, might be placed in these categories:

1. Solar or cosmic.
2. High energy electron.
   (a) capacitron
   (b) resonant transformer
   (c) Van de Graaff accelerator
   (d) linear accelerator, etc.
3. Nuclear.
   (a) fission products
   (b) neutron
   (c) gamma
   (d) radioactive isotopes, etc.
4. Biological.
   (a) living tissue
   (b) seeds
   (c) chemical fertilizers, etc.

Reasonable strides have been made in discovering the composition of solar or cosmic radiation and its effect on biological and physiological specimens.

In the Pennsylvania Agricultural Experiment Station, departmental representatives have indicated possible radiation interests and problems as follows:

Animal nutrition—sterilization of diets for long-term experiments.

Forestry—no definite problems, but reactor facilities undoubtedly will be used in the future.

Dairy science—sterilization of milk, cheese and ice cream mixes; cheese ripening; effects of radiation on metabolism of spermatozoa; induction of mutations by irradiation of spermatozoa.

Agricultural engineering — fundamental studies of the distribution and utilization of energy.

Horticulture — seed treatment; induction of mutations; surface sterilization of sera; vaccine production; effect of radiation on susceptibility of cells to viruses.

Agronomy—treatment of grains for insects and disease; inhibition of potato sprouting; induction of mutations.

Botany—induction of mutation in pathogens.

Agricultural Biochemistry—effects of radiation on plant metabolism; interdepartmental cooperation.

Bacteriology — inactivation of organisms for vaccines; effect of radiation on the cell.

While it is not yet clear which type of radiation offers the greatest possibility for experimental use for foods, seed, animals, or biological specimens it is to be expected that facilities which provide controlled accelerated particles will play an equally important role with fissionable radiation.

A survey compiled by the Atomic Industrial Forum from records maintained by the Isotopes Extension of the Division of Civilian Application, United States Atomic Energy Commission from August 2, 1946, to February 9, 1956 shows that *(a)* over 100 radioisotopes are in use, *(b)* in a total of 1347 installations and *(c)* in 43 states, Hawaii and District of Columbia.

EDITOR'S NOTE: In 1956 President Bainer established a Special Committee on Radiation to give special attention to new developments in radiation phenomena, related equipment, and applications which might be utilized by agricultural engineers in the interest of agriculture. Since then, some members have shown concern that ASAE take an active interest in present and potential agricultural and engineering applications of atomic science and nuclear radiation. At its meeting at East Lansing in June, 1957, the ASAE Council assigned to the Committee on Radiation the function of giving particular attention to the Society's interests in atomic radiation and nuclear engineering. At this stage, the Committee's work is largely exploratory. The Committee personnel are: John E. Nicholas, chairman, F. C. Jacob, K. H. Norris, V. H. Baker, D. E. Wiant, J. K. Jensen, F. G. Wratten, C. F. Kelly, Andrew Hustrulid and S. O. Nelson.

This contribution by Mr. Nicholas follows presentation in March (Page 177) of the preliminary objectives of the Committee. It suggests some of the phases and applications of radiation to which the Committee will be giving further consideration. Mr. Nicholas hopes that it may also encourage additional agricultural engineers to develop their interest in radiation and to identify themselves with agricultural engineering progress in utilizing it.

The author—JOHN E. NICHOLAS—is professor of agricultural engineering, Pennsylvania State University, University Park, Pa.

Soil Pressure Distribution
Under Tractor and Implement Traffic

G. E. VandenBerg, A. W. Cooper, A. E. Erickson, W. M. Carleton
Assoc. Member ASAE Member ASAE Member ASAE

LARGE farm tractors which develop more power and require more weight for traction purposes are becoming a problem of increasing importance. In particular, the distribution of weight of a tractor resulting in soil pressures which cause compaction seems to be of great importance. Recent development of a strain gage pressure cell (transducer) for measuring pressures in soil (1)* provides a means of determining the magnitudes and the distribution of pressure under applied loads.

The plowing demonstration held in conjunction with the "Powerama" at Chicago, Ill. in September, 1955, provided a rare opportunity to study the pressure distribution under tractor and equipment tires. The Detroit Diesel Engine Division of the General Motors Corp. and The Oliver Corp. staged the plowing demonstration. Fourteen train carloads of Maumee sandy loam soil were shipped in to cover a paved 60 ft by 300 ft area to a depth of about 15 in. A strip 40 ft wide down the center of this artificial field was plowed with a 6-bottom 16-in. plow. Moisture was added when necessary with a pressure sprayer. The soil was recompacted after plowing with a 38-in. diameter sheepsfoot tamper and a multi-wheeled pneumatic tired roller. This cycle was repeated approximately 11 times daily for the 26 days duration of the show. A pyrosene cover was placed over the soil at night and during rainy weather to permit control of moisture added to the soil.

A cooperative investigation to measure pressure distribution in the soil and the physical soil changes was carried on by the Agricultural Engineering Research Division, USDA, and the agricultural engineering and soil science departments, Michigan State University. This article deals specifically with the use of strain gage cells to measure pressures in the soil and the analysis of the data collected during the plowing cycles.

*Numbers in parentheses refer to the appended references.

Paper prepared expressly for AGRICULTURAL ENGINEERING and is authorized for publication as Journal Article No. 1979 of the Michigan Agricultural Experiment Station. It is a joint contribution of the Michigan Agricultural Experiment Station and the U.S. Department of Agriculture.

Acknowledgments: The authors wish to thank the General Motors Corp., The Oliver Corp., and the Offner Electronics Corp. for cooperation in carrying out these tests.

The authors—G. E. VANDENBERG, A. W. COOPER, A. E. ERICKSON and W. M. CARLETON—are, respectively, graduate research assistant, Michigan State University; assistant head of the National Tillage Machinery Laboratory, Auburn, Ala.; associate professor of soil science, Michigan State University and former professor of agricultural engineering, Michigan State University.

Apparatus

Each strain gage cell had a stainless steel top, 2 in. in diameter and 0.025 in. thick. Two SR-4 strain gages (type A-18) were cemented to the under side of each top. The strain gages were ⅛ in. in length, 120 ohms in resistance, and had a gage factor of 1.73. Two additional gages from the same lot were cemented to the sides of the ¾-in. thick brass body of the cell to give temperature compensation and to complete the wheatstone bridge. The cells, calibrated in a water pressure chamber, were linear within the range of 0 to 40 psi. A 6-channel direct-inking recording oscillograph was used to record the pressure readings.

Procedure

Six of the cells were buried 0.4 ft apart on center, at the same depth, and on a line perpendicular to the direction of

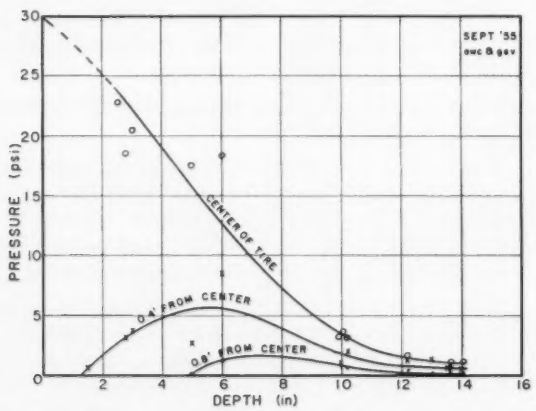

Fig. 1 *(Above)* Averaging curves showing pressure distribution under front tractor tire in dense Maumee sandy loam soil placed on pavement

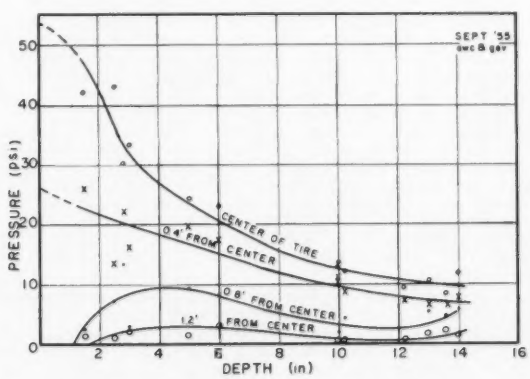

Fig. 2 *(Right)* Averaging curves showing pressure distribution under rear tractor tire in dense Maumee sandy loam soil placed on pavement

The occasion of a staged plowing demonstration provided an opportunity to record soil pressure under artificial field conditions

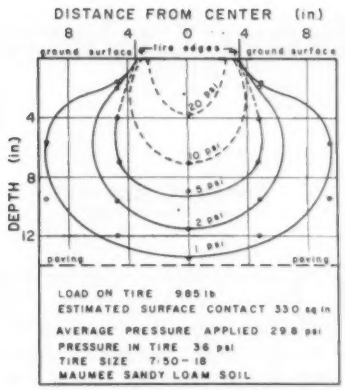

Fig. 3 Isopiestic lines under front tractor tire in dense soil placed on pavement

travel of the tractors and equipment, and always below the depth of plowing. The group of cells was relocated at various depths several times during the demonstration and pressures were recorded under all traffic that passed over the cells. To obtain pressure measurements under the tractor tires at depths less than the depth of plowing, the group of cells was so located that the back furrow made by the plow would fall as near over the center of the group of cells as possible. On the next pass, the front and rear wheels of the tractor that were in the furrow would pass over the cells which were then sometimes at depths as shallow as 1 in. On every pass over the cells the depth of soil between tires and cells and the location of the center of the tires with respect to the group of cells were recorded. Contact areas of the tires and implements, weights of the tractors and implements, pull of the implements, and other information necessary to determine the load on each wheel that passed over the cells were recorded.

Results

Assumptions were made since it was not possible to interrupt the plowing demonstration often for precise measurements. The load on each wheel and implement was assumed to be constant during the tests. Average values of "weight transfer" in the tractor were used in determining the total load on each wheel. Each wheel was assumed to have an elliptically shaped contact surface and thus the contact areas could be calculated by measuring the semi-axes of the elliptical contact areas. The one exception to this was the rear wheel of the tractor pulling the plow. The soil was extremely dense and since the lugs on the rear wheel did not penetrate the soil enough to allow the body of the tire between the lugs to touch the soil, only the lug area touching the soil was considered as contact area. A summary of the loads, pressures and contact areas is given in Table 1.

The contact area for the tractor tires during the tamping and rolling operations varied so much that the authors felt it would be impractical to try to obtain these areas. The maximum pressures under the tamping feet were obtained by averaging the highest cell reading for each pass over the cells. The average pressure was obtained by averaging the readings of the six cells for each pass over the cells. The reported pressure was considered to be an average under the roller packer. The above qualifications apply to data reported in Table 1.

An attempt to determine the distribution of pressure under the front and rear wheels of the tractor pulling the plow was made by plotting the measured pressures with respect to the center of the tire and depth below the tire. Apparent variations in the data, and inability to measure distances precisely would not permit connecting points of equal pressure with smooth curves. Therefore, another method of analysis was attempted.

It was observed that when a tire passed near the center of the group of cells, one of the cells had a higher reading than any of the others. The adjacent cells indicated gradually lower pressures as they were located farther from the cell having the highest reading. Consequently it was assumed that the cell having the highest reading was directly under the center of the tire. This assumption seems justified for three reasons. Even though the cell might not have been

(Continued on page 859)

TABLE 1. SUMMARY OF LOADS CARRIED, CONTACT AREAS AND PRESSURES MEASURED IN MAUMEE SANDY LOAM SOIL PLACED ON PAVEMENT

Tractor tire or implement	Pressure in tire (psi)	Load carried (lb)	Estimated contact area (sq. in.)*	Average pressure applied (psi)‡	Measured pressure 10 in. below surface (psi)
Front tire plowing	36	985	33.0	29.8	3.5
Rear tire plowing	16	4505	84†	53.6	12.5
Front tire watering	36	1350	100	13.5	5.8
Rear tire watering	16	4127	396	10.4	14.0
Front tire tamping	36	1265	—	—	5.4
Rear tire tamping	16	4212	—	—	12.9
Front tire rolling	36	1360	—	—	6.0
Rear tire rolling	16	4117	—	—	12.5
Sprayer tire	31	2852	692	41.3	13.8
Tamping feet, maximum psi	—	8550	156	51.4	8.0
Tamping feet, average psi	—	8550	156	51.4	5.6
Roller packer	—	4365	226	19.3	1.7

*Elliptical contact area assumed except under tamping feet.
†Only lug area in contact with soil.
‡Load carried divided by estimated area.

New Criterion of Size for Agricultural Products

Robert K. Houston
Assoc. Member ASAE

Properties and requirements of a hypothetical machine are introduced as a guide for design of an ideal product sizer

ONE step in the preparation of an agricultural product for market is segregation of the product into several size categories. This operation — called size-grading, or sizing — helps bring higher financial returns because of consumer preference for certain sizes and because of the high sales appeal of a display of fruit that looks uniform in size.

At the present time, large-scale sizing is usually done in one of three ways:

- By measuring a diameter of each fruit.
- By weighing each fruit.
- By human judgment.

Each industry has tended to base its size standards on one of these three methods. This indicates lack of agreement on a single size criterion that is readily measurable by present techniques. The most common size designation refers to the number of fruits of specified size required to fill a standard container. This apparently implies a volume criterion.

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Acknowledgments: The author is deeply indebted to J. B. Powers, agricultural engineering department, University of California, for his assistance and guidance in this study.

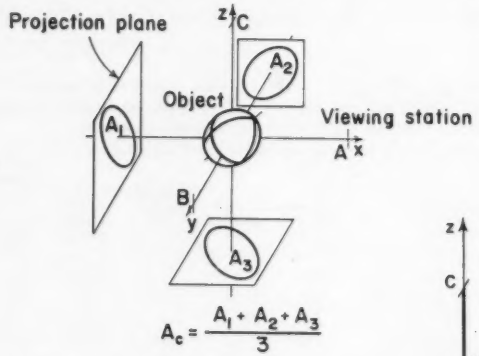


Fig. 1 *(Above)* Example of a body represented by its orthogonal projections along three mutually perpendicular axes. This is a general case where the axes of projection do not coincide with the axes of the body. The criterion area is defined as the arithmetic average value of the three projected areas

The shortage and high cost of agricultural labor have led to the development of the volume-fill pack with fruit fed directly into a container from a belt. The container is vibrated during the filling operation to settle the fruit into a tight pack (1)*. Accurate sizing on a volume basis is required if a specified number of fruits are to fill the container. Therefore, the evaluation of size criteria in this article is based on the premise that they should be closely related to measurements of volume.

Diameter sizing is not a suitable measure of volume because of the variation in shape of any particular product. Weight sizing is suitable for some products, but for others, notably citrus fruits, the variation in specific gravity is too great for satisfactory sizing by weight. Human judgment is also too variable for consistently accurate sizing. The fact that manual sizing has not been replaced by mechanical sizers in all large-scale operations indicates that present methods are not entirely satisfactory. To overcome the deficiencies of present sizing methods, a new criterion of size is needed.

Engineers are accustomed to representing an object graphically by drawing three mutually perpendicular projections of the object. These three projections describe the object reasonably well regardless of its orientation to the three axes of projection. Therefore, it would be logical to expect the projected areas of an object, taken along three mutually perpendicular axes, to be a good indication of the size of the object. The projected area can be measured quite precisely by means of a photoelectric cell.

A new criterion of size, then, may be defined as the arithmetic value of the projected areas taken along three mutually perpendicular axes. We shall call this value the *criterion area* (A_c). Fig. 1 illustrates the criterion area in a

*Numbers in parentheses refer to the appended references.

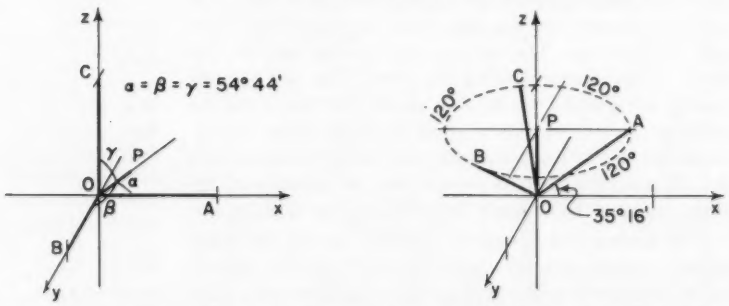


Fig. 2 Rearrangement of axes from Fig. 1 to the arrangement discussed in text. *(a)* Consider line *OP* which forms equal angles with the coordinate axes. These angles are each 54 deg, 44 min. *(b)* Line *OP* and the viewing axes *OA*, *OB*, and *OC* have been rotated about *O* until *OP* coincides with the *z*-axis. Each viewing axis forms an angle of 35 deg, 16 min with the horizontal plane and the viewing stations lie at 120-deg intervals around circle *ABC*. The projection planes of Fig. 1 have been rotated along with the viewing axes but are not shown

general case where the orientation of the body with respect to the viewing axes is unrestricted.

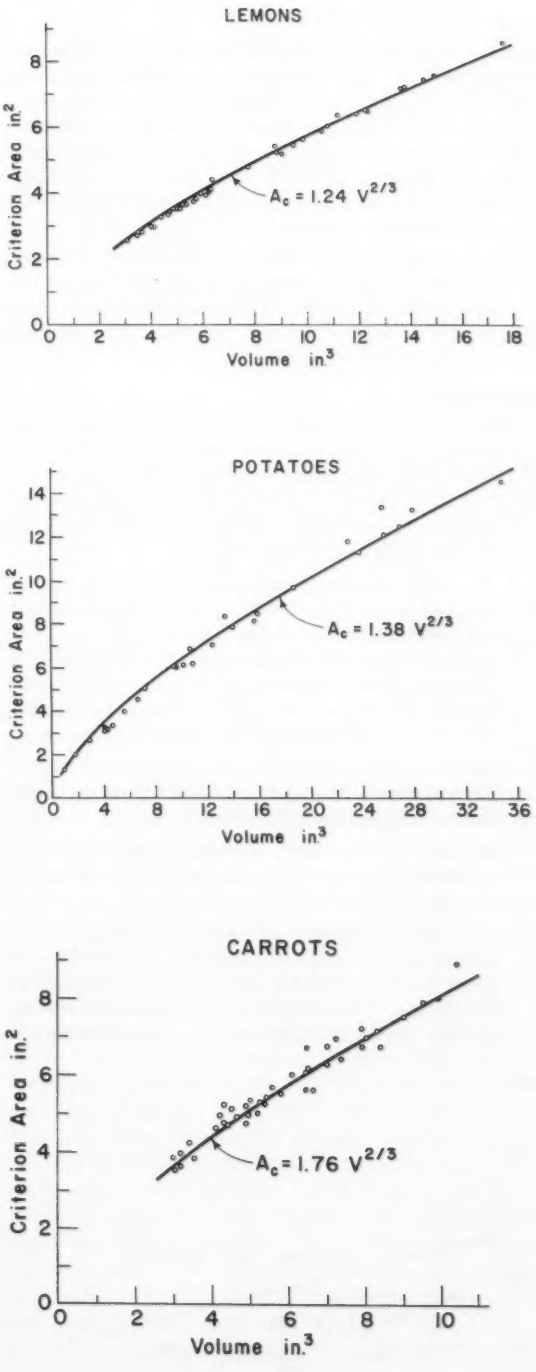
A mathematical analysis of simple geometric bodies showed that the variation of criterion area for unrestricted orientation was too great for a consistently satisfactory measure of volume. However, this variation was reduced to an acceptable level by restricting the bodies to a natural rest position on a horizontal plane and rearranging the viewing axes so that each axis formed an angle of 35 deg 16 min with the horizontal plane (2). This arrangement of axes is shown in Fig. 2. From a practical point of view, unrestricted orientation could occur only in free fall. Free fall eliminates use of the machine on such easily damaged products as tomatoes, pears, peaches, and avocados. A preferable arrangement would convey the fruit horizontally through the measuring unit on a transparent or open grid belt and would arrange the axes of projection so they are symmetrical with respect to the belt as shown in Fig. 2 (b).

New Criterion

Experimental measurements were made to determine the relationship between criterion area and volume of lemons, potatoes, and carrots. To evaluate the validity of this criterion of size, the experimental measurements included *(a)* variation of criterion area with orientation, *(b)* variation of criterion area with shape, and *(c)* variation of criterion area through the size range for each product tested. The results of these measurements are shown in Figs. 3, 4, and 5. In these figures, the abscissas are the volume in cubic inches and the ordinates are the average criterion area of each specimen, as obtained from some eight different orientations of the specimen with respect to the viewing axes. The preliminary mathematical analysis indicated that the relationship between criterion area and volume should be of the form $A_c = KV^{2/3}$ where K is a dimensionless constant related to the typical shape of the body. This equation was applied to the experimental measurements. The value of K, determined by the method of least squares, was found to be 1.24 for lemons, 1.38 for potatoes, and 1.76 for carrots.

The validity of this criterion of size as a measure of volume is indicated in Fig. 6 showing the probable error in volume measurement resulting from a single measurement of criterion area for each of the three products. The error in this case is the difference between the curve value of volume expressed in Figs. 3, 4, or 5 and the true volume of the specimen. For example, the criterion area of a lemon is measured at some random orientation (within the limits set forth above). The expression $A_c = 1.24\,V^{2/3}$ gives a corresponding volume for the measured area that will probably be in error from the true volume by the relationship for lemons shown in Fig. 6. The mean probable error is 3.7 percent for lemons, 6.5 percent for carrots, and 8.3 percent for potatoes. Since the volume error is three times the diameter error, this corresponds to a diameter measurement of all three diameters with an error of 1.2, 2.2 and 2.8 percent, respectively. These errors include variations in orientation and variations from the "typical" shape. Since the errors are relatively small, they do not greatly affect the volume measurement.

The variety of products to which the criterion will apply is indicated by the products measured in this study. Lemons represent symmetrical, nearly spherical products, and carrots represent symmetrical, elongated products. Between these shapes we find such products as citrus fruits, apples, peaches,



Figs. 3, 4 and 5. Experimental results of criterion area as a function of volume for lemons, potatoes and carrots, respectively. Plotted points are the arithmetic average value of criterion area measured from several orientations of each specimen. Data conform closely to theoretical curve shown on each graph. • In Fig. 4 note great range of sizes from 1 cu in. to 35 cu in. In Fig. 5 data have greater spread than lemons or potatoes, but still conform closely to theoretical curve

. . . Criterion of Size

tomatoes, apricots, plums, various melons, and cucumbers. Potatoes represent non-symmetrical products having large variations in "typical" shape. Other products such as pears, avocados, and bell-peppers would be suitable for measurement by this criterion, since their shapes lie between those of lemons and potatoes. Probably such products as chili-peppers and various squashes can also be measured satisfactorily with some reduction in accuracy.

Fig. 7 shows various members of the family of curves $A_c = KV^{2/3}$ indicating the range of values that a sizing machine would have to handle. The lower limit is definitely the curve for spheres. The upper practical limit appears to be close to the curve for carrots.

Advantages

What are the advantages of using this criterion of size? This question cannot be answered until a machine that uses this criterion has been built. However, the experimental data give some bases for speculation. We may consider seven properties of an ideal sizer and see how a sizer using criterion area might conform to them:

- *An ideal sizer would segregate a product so that individual pieces in a size category look uniform in size.* One experiment was made during these studies to evaluate the proposed criterion for this property. The experiment was not extensive enough to permit any definite conclusions, but it did indicate good possibilities for this method regarding visual uniformity.
- *An ideal sizer would be adaptable to many products.* The experimental work proved that the criterion area method would satisfy this requirement.
- *An ideal sizer would be accurate.* Again, the experimental work has shown this method to be highly accurate.
- *An ideal sizer would be simple.* Our hypothetical sizer would not be as simple as the simplest diameter sizers, but the individual components would not be complicated. For example, the circuitry of the measuring unit would not be as complex as an ordinary kitchen radio. The operating adjustments would be equally simple. There is apparently no reason for high complexity in such a sizer.

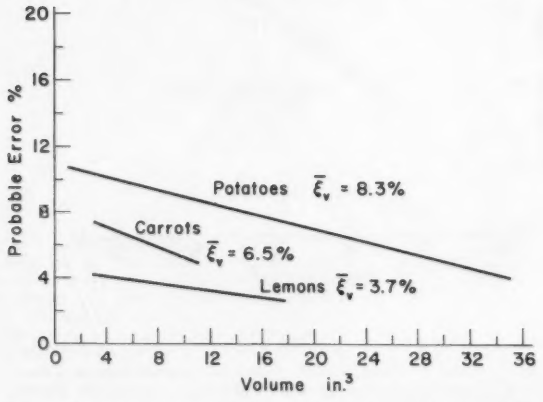


Fig. 6 Probable error in volume measurement as a function of true volume which would result from a single measurement of criterion area. The error, shown in percentage, is the difference between the curve value of volume expressed in Figs. 3, 4, or 5 and the true volume of the specimen. $\bar{E}_v$ is the mean probable error

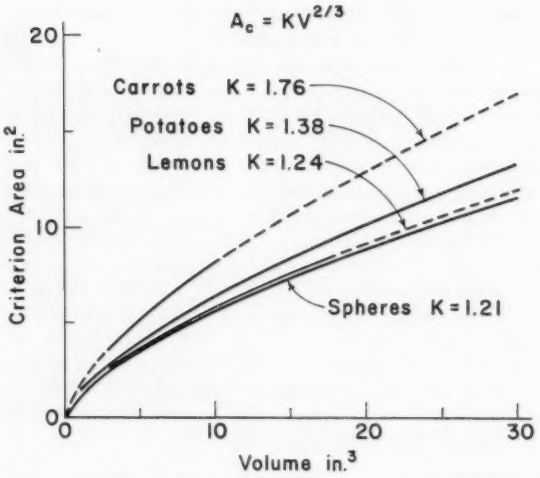


Fig. 7 Comparison of experimental results with the computed curve for spheres. The curve for carrots and the curve for spheres very nearly bracket the range of values through which a practical sizer would have to work

- *An ideal sizer would have a high capacity.* Past experience with electronic measurement of agricultural products indicates the limiting factor to be the mechanical handling of the fruit. Each operation such as singling or orienting the fruit reduces the capacity, thus a machine that both singles *and* orients has a lower capacity than one performing either of these functions alone. The proposed sizer has the advantage of not requiring a specific orientation of the fruit; it needs only to be singled. Additional capacity can be gained by using multiple units.
- *An ideal sizer would not damage fruit.* Each operation that requires mechanical handling increases the total amount of fruit damage. Eliminating the orienting operation will reduce this damage. Furthermore, electronic measurement itself cannot damage the fruit, since there is no mechanical contact. Therefore, this sizer should damage fruit less than present methods.
- *An ideal sizer would have a low first cost.* One of the factors contributing to a high first cost is a limited market allowing only a limited production. A sizer using criterion area would have nearly the entire field of agriculture for a market. This means a large volume production might be possible to help reduce the first cost.

As stated previously, the ultimate value of this criterion of size cannot be determined until an experimental model has been built. The evidence at hand, however, indicates the possibility of producing a sizer with nearly ideal properties.

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. . . Soil Pressure

(Continued from page 855)

directly under the center of the tire, it certainly must have been under the center of the greatest load applied by the tire since that would cause the highest pressure in the soil. Secondly, over a number of readings the fact that the cell may have been either to the left or to the right of the center of the tire should result in average values of pressure under the center of the tire. Thirdly, in most cases, horizontal distance measurements verified the assumption. Therefore, the pressures indicated by the cell having the highest reading for each pass were plotted on a graph having pressure on the ordinate and depth on the abscissa. A smooth curve was drawn through these points and labeled "center of tire" since this curve should represent average pressure values under the center of the tire. This procedure was followed for both the front and rear tires of the plowing tractor. On the same respective graphs the average values of the next pair of adjacent cells were plotted and the smooth curve drawn through these points was labeled "0.4 ft from center" since these cells should represent pressure values 0.4 ft from the center of the tire. The next pair of adjacent cells was then averaged and plotted in a similar manner and labeled "0.8 ft from center". The process was continued until zero pressures were encountered.

The respective sets of averaging curves (Figs. 1 and 2) represent the pressure distribution under the front and rear tires of the plowing tractor. However, it is hard to visualize the pressure distribution from these curves. Thus, it was decided to take values from the averaging curves to plot isopiestic lines, lines of equal pressure, under the tires. This was done in the following manner: To plot one isopiestic line a selected pressure value was chosen. This value was followed across the respective averaging graphs (Figs. 1 and 2) until the chosen value was crossed by one of the averaging curves. At the point of crossing, the abscissa of the averaging graphs indicated the distance below the tire where the pressure occurred, and the averaging curve itself, indicated the distance from the center of the tire that the pressure occurred. A point was then plotted on the respective isopiestic graphs (Figs. 3 and 4) according to the values indicated at the point of crossing on the averaging graphs. Since the averaging curves did not represent a right or left of the tires, points not under the center were plotted on both sides of the center of the tires. When the points represented by all the averaging curves crossing the chosen pressure value had been plotted, a smooth curve drawn through the plotted points represented the isopiestic line for the chosen pressure value. This process was continued until the desired number of isopiestic lines had been plotted. These families of isopiestic lines (Figs. 3 and 4) then represented the pressure distribution under the tires for the conditions encountered. Isopiestic lines could not be determined under any of the other traffic since the depth of plowing made pressure measurements impossible at depths less than approximately 10 in.

Each isopiestic line was determined by points from at least two averaging curves except those at shallow depths near the center of the tires. There, because the pressure distribution of the contact surface was not known, the isopiestic lines were drawn arbitrarily. The method has added merit when considering that the conditions at the plowing demonstration were probably controlled much closer than could be expected in field work.

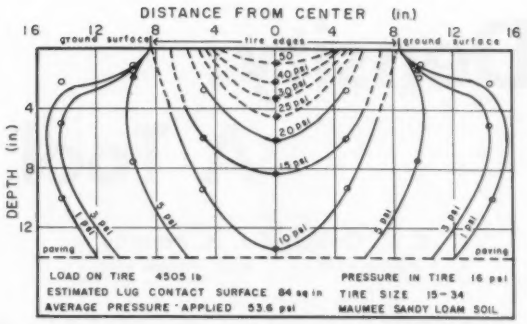

Fig. 4 Isopiestic lines under rear tractor tire in dense soil placed on pavement

After one complete demonstration cycle very little change occurred to the soil near the cells. Similarly the soil was as uniform as could be expected for each plowing. In spite of the unusual soil uniformity, there was still considerable variation in the readings. This would be expected, since it was impossible to have conditions exactly the same every time a reading was taken. Thus, one will expect even more variation in actual field conditions and some method will be needed to smooth out these variations in order to get a representative picture of the pressure distribution for a given situation. A method of graphical analysis is offered as a possible means of achieving that goal.

The authors feel that one word of caution about the isopiestic graphs is necessary. Because of the nature of the pressure cells, they measure only the pressure normal to the face of the cells. In the position placed, for this work, the cells measured only pressures in the soil in a vertical direction. It seems doubtful that the pressure was always in the vertical direction thereby causing the isopiestic lines to be in error. In analyzing the data only the peak values of pressure indicated by the cells were used, which means that for the values reported the wheels should have been directly over the line of cells. Therefore, the pressure should have been applied in the vertical plane through the line of cells. Similarly within the vertical plane, the cells that were directly under the center of the tires should have been subjected to vertical pressures. Thus, probably the only place where the pressure was not in a vertical direction, was near and beyond the outer edges of the tires. Therefore the authors feel that the isopiestic graphs represent fairly accurate pressures in the center one-half of each tire. Even though the pressures measured were in an artificial field, the general shape of the isopiestic lines and the magnitude of the measured pressures are probably quite close to that which would be expected in a natural field having the same physical properties as those of the soil used at Powerama.

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Density: A Tool in Silo Research

C. K. Otis and J. H. Pomroy
Member ASAE Assoc. Member ASAE

(Continued from November)

Regardless of the method used, weighing all of the silage is necessary to serve as a check on the accuracy of the determination.

Another method that has been used is the *horizontal core sampling method* that samples the silage before any of it has been removed from the silo, eliminating the possibility of the density changing as the weight is removed when feeding off the contents. It has the further advantage of revealing the variation of density throughout the mass. Since this method gives the greatest promise for analyzing the physical characteristics of the silage it will be described in detail.

Fig. 6 shows an experimental silo equipped for sampling by this method with the operation underway. Portholes are provided to give access to the silage at vertical intervals of 5 ft and designed to give an air tight seal when closed. Supports are also provided for attaching, to the silo wall, the operator's platform and the sampling equipment. The 4-in O.D. seamless steel tube has a cutting edge on one end and a turning head on the other (Fig. 7). The tube is supported in a horizontal position by a frame and a cross-head that travels along two pipe guides (Fig. 6). When operating, the tube is rotated a small amount back and forth as it is forced into the silage by the crosshead pulled toward the silo by cables passing over sheaves and doubled back to the rear of the frame where a hand-operated winch provides the pull. A tool resembling a large cork-screw (Fig. 7) is used to free the cut sample from the cutting teeth as protection against a plug forming in the tube. This tool is also used to extract the sample from the tube.

The authors—C. K. Otis and J. H. Pomroy—are, respectively, professor and instructor of agricultural engineering at the University of Minnesota.

The sequence of operations after the sampler is lined up and leveled is as follows:

1 Cutting end of tube is moved through the open porthole to contact the silage.

2 A measuring rod is passed through the tube until it contacts the silage. The distance to a reference point on the stationary frame is recorded.

3 A sample is cut to a depth of approximately one foot and is removed for weighing.

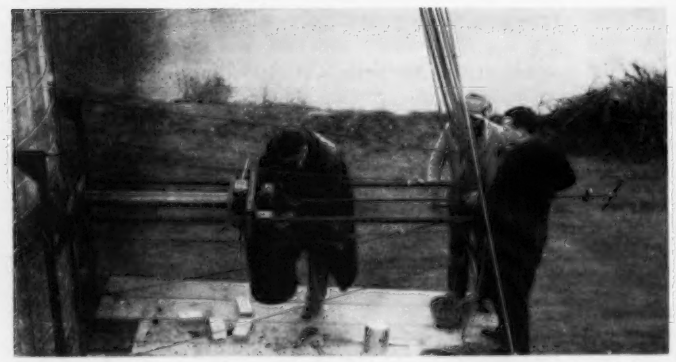
4 The measuring rod is again inserted and the new reading of the rod recorded.

5 The process is repeated for each foot across the silo diameter.

6 Knowing the diameter of the cutter, the depth of the hole, and the weight of silage removed the density of the sample can be computed.

Plotting these data on a cross section plan of the silo, lines of equal density can then be determined by interpolation between points. With this done and shading provided to represent density ranges, density diagrams can be prepared.

A series of such diagrams appear in Figs. 8 through 11. Fig. 8 shows the diagram made from data obtained during the first year the silo was filled. The first cutting alfalfa was placed with a blower equipped with a hanging distributor pipe and a man was kept in the silo to distribute and tramp. Fairly uniform layers were formed with density generally increasing from top to bottom of the silo. However even where careful distribution was provided there appears a dense layer overlaying a less dense layer and a ring of light silage surrounded by more dense material at about the center of the mass. This was verified while unloading



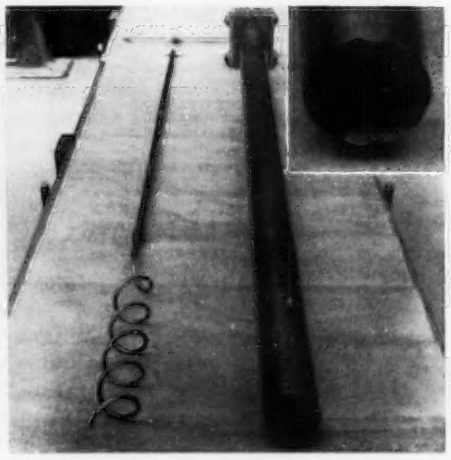


Fig. 6 *(Above)* Horizontal core sampling in progress at the experimental silo. Sample is being removed from tube with large corkscrew device • Fig. 7 *(Right)* The sampling tube and corkscrew device used to remove silage from the tube. Inset shows cutting edge of sampling tube

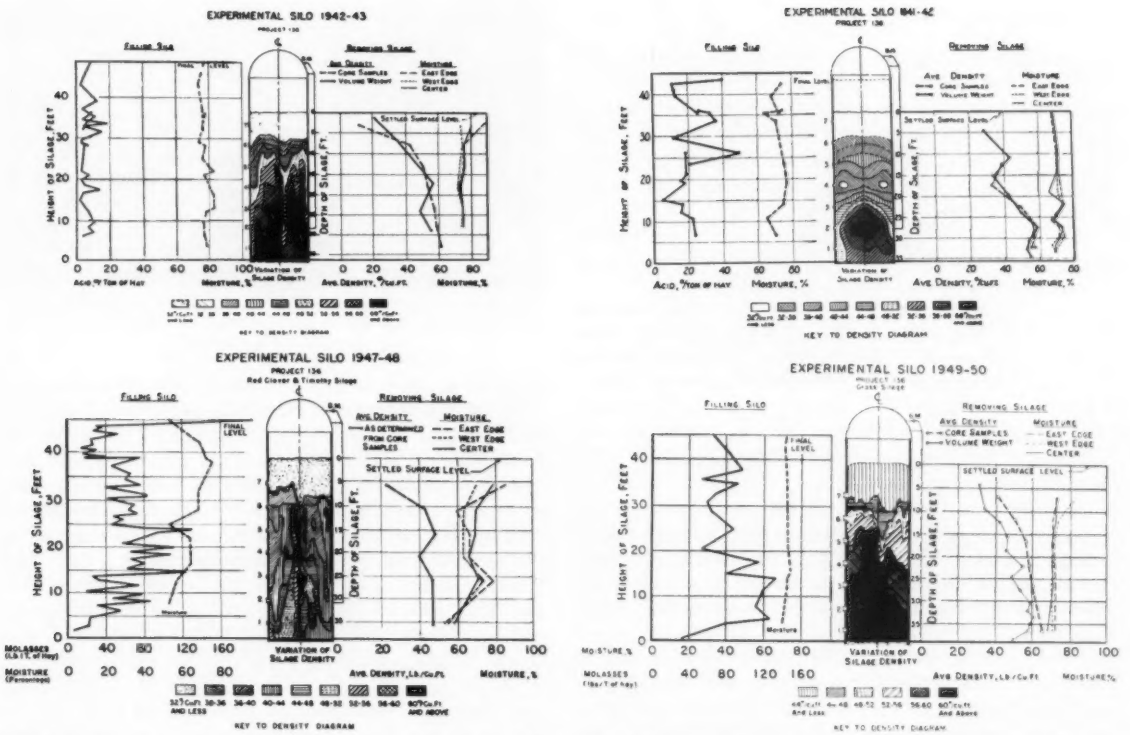


Fig. 8 *(Upper left)* Variation of alfalfa silage density in the first filling of the experimental silo in 1941 is shown in the silo cross-sectional diagram. Rate of application of phosphoric acid, variation of moisture content of the green material, average density curves (one based on core samples and the other on the layer method) and the final moisture content of the silage are shown. Note the density inversion shown in the diagram • Fig. 9 *(Upper right)* Pillars of dense silage formed in alfalfa silage during 1942 as a result of techniques used in filling the silo • Fig. 10 *(Lower left)* Density is high at the center of the silo filled with wilted red clover and timothy treated with molasses • Fig. 11 *(Lower right)* Formation of a dense pillar of silage to one side of the center is not desirable since it may set up an overturning moment within the silo

the silo when a doughnut-shaped ring of moldy, light silage was uncovered with more dense and good quality silage in the hole of the doughnut and between the ring and the wall. The probable cause of these seeming irregularities have not been explained but it is assumed that the character of the green material and the care with which it was placed were primarily responsible. Average density as related to depth below the settled surface is portrayed by two curves to the right of the central diagram. The solid line was drawn from data obtained by the layer method and the broken line was made from the core sample data. The shapes of both density curves reflect the shape of the curve representing the moisture content of the green material shown at the left. This tends to indicate that moisture content of the green material is an important factor in the resulting density of the final product.

Fig. 9 shows quite a different story. The moisture content of the green material in 1942 was somewhat higher and more uniform and the material was again first-cutting alfalfa direct cut in the field. However, a different method of distribution was used. Two or three loads were placed in the silo and then a man with a fork leveled it off, another two or three loads were blown in and again it was leveled. This process was continued until near the top when a man was needed full-time in the silo to keep the chopped alfalfa away from the blower pipe. Notice in this diagram the presence of dense columns of silage extending from the bottom to points 8 to 16 ft above the bottom, separated by areas of less dense material. This diagram was nearly destroyed because the results seemed so unlikely.

In 1947 the silo was filled with wilted red clover and timothy (Fig. 10). A slender core of dense silage extended upward through the center of the mass and there was considerable variation throughout. Again the average density curve reflected the shape of the moisture content curve of the green material.

Fig. 11 shows a pattern of densities resulting from the ensiling of a rather uniform moisture content alfalfa. Notice in this diagram the dense silage built up in a pillar-like formation, slightly off center in the silage mass. Poor distribution may be indicated by the rather large difference in the depth density curves determined by core sampling and by the layer method.

In most of the diagrams it can be seen that dense pillars of silage have been formed that support tons of silage on relatively small areas of the silo bottom even when distribution of the green material during filling has been done by methods considered to be good practice.

Further evidence that these columns support the mass above is supplied by other data. Vertical pressures on the bottom have shown non-uniformity and spot pressures have exceeded calibration of the pressure-measuring device. It was originally felt that the device was not functioning properly. Unusually high densities in small areas were obtained

. . . Density

by core sampling, some of which were nearly 75 lb per cu ft. Recent attempts to reproduce densities of this high value in the laboratory indicate that pressures of 8000 lb per sq ft or greater may be required. When the entire contents of the silo, usually close to 180 tons, is distributed uniformly over the silo bottom a pressure of approximately 2500 lb per sq ft can be expected.

All of these observations tend to show that a substantial proportion of the silage mass may rest on pillars of dense silage that have built up during the filling process.

What is the significance of these diagrams? For one thing they point out the futility of trying to predict accurately the capacity of a silo from figures obtained from a table based on average densities such as given in Table 1 derived from several years' data for high-moisture alfalfa silage stored in the experimental silo, even though such tables are necessary to get some idea of the size requirements for the storage structures.

Another factor to consider is the performance of silo unloaders in silage that contains hard spots caused by pillar formation during filling. This is particularly important where unloading is done from the bottom since the greatest density within the pillars would be found at the bottom of the silo.

From the structural standpoint, however, there may be a far more important problem. Usually silos are designed in the same manner as are water tanks with the assumption that lateral pressures, at any given level of the silo, are uniform around the inside of the wall and vertical pressures are distributed uniformly over the bottom. However, when dense columns of silage build up as indicated in the diagrams there is danger of eccentric loading and a moment may be introduced that under certain circumstances may cause the silo to overturn. No amount of hooping is likely to prevent a silo from overturning if enough eccentricity is introduced due to careless filling methods. If in filling an upright silo the contents were distributed uniformly there would be no force within the silo to cause overturning even if the lateral pressures were high.

Fig. 12 shows a steel silo that overturned soon after filling. When conditions are right the tremendous weight of the silage within may cause the structure to overturn due to the building up of unfavorably located pillars of dense silage during filling. Such failures are not necessarily the result of a poorly-designed structure but are more likely the result of careless filling methods. The silo in Fig. 12 was

Table 1. Average Weight per Cubic Foot of Settled Unwilted Alfalfa Silage and Capacities of Silos of Various Diameters

(Alfalfa Entering Silo at 72-78 Per Cent Average Moisture Content)

Depth of settled silage*	Average weight per cubic foot for all silage above depth indicated	Quantity of settled silage			
		Silo diameter (inside)			
		12 feet	14 feet	16 feet	18 feet
Feet	Pounds	Tons	Tons	Tons	Tons
2	16.9	1.9	2.6	3.4	4.3
4	22.7	5.1	7.0	9.1	11.5
6	27.3	9.3	12.6	16.5	20.8
8	31.1	14.1	19.2	25.1	31.7
10	34.1	19.5	26.3	34.3	43.4
12	36.7	24.9	33.9	44.3	56.1
14	38.8	30.7	41.8	54.7	69.1
16	40.5	36.7	49.9	65.3	82.5
18	42.1	43.0	58.5	76.5	96.6
20	43.5	49.2	67.0	87.6	111.1
22	44.8	55.7	75.8	99.2	125.5
24	45.9	62.4	84.9	111.0	140.6
26	47.0	69.1	94.1	123.0	155.6
28	48.0	76.0	103.4	135.2	171.2
30	48.8	82.9	112.8	147.5	186.7
32	49.6	90.0	122.5	160.1	202.9
34	50.7	97.6	132.9	173.8	219.9
36	51.5	104.9	142.8	186.8	236.0

* Measured from the surface of the settled silage before any is removed from the silo.

Fig. 12 Careless filling methods may contribute to overturning failures such as this, due to the formation of dense pillars of silage in undesirable locations

filled about one-half full of corn that was somewhat drier than that considered best for silage. No leveling was done until the end of the day when the top of the silage was leveled off. The next day filling was completed with corn considered about ideal. Several days later it was refilled with green corn. Failure occurred on the day following the refilling. It seems likely that the formation of a pillar, along the center line of discharge from the blower, might have been a contributing factor in this silo failure. Concrete stave and other masonry silos that have no vertical reinforcing and no anchors have also failed in this manner but their greater weight makes them somewhat less susceptible.

Knowing that such pillars can build up under certain conditions it is important to control their effect on the stability of the silo. If they form in the center or in a symmetrical pattern on the bottom no harm is likely to develop. But if they form well to one side or are slender enough to collapse under load, creating an unbalanced lateral pressure distribution, they may well cause the silo to fail by overturning. To be safe, against overturning, a silo must either be designed for any possible eccentric loading or a method must be devised, for filling, that will prevent eccentric loading within the structure.

In 1955 it was planned to see what effect mechanical distribution would have on the resulting density pattern. The distributor used was mounted at the center of the silo just under the blower discharge. The device rotated in response to the silage passing through it and directed the material towards the walls as it rotated. Fig. 13 shows the results. The distributor did not work well because of low silage velocity in the blower pipe and distribution was not as good as was hoped for. Pillars are still apparent but in this case more uniform distribution was obtained. The highest density recorded that year was 63 lb per cu ft and at the lower level the difference between the lowest and the highest density was only 7 lb per cu ft, whereas a difference of 15 lb per cu ft was found in 1949.

Fig. 14 illustrates (by following lines of equal density) the probable distribution pattern of the original green material entering the silo. The circle of distribution appears to get smaller as it approaches the top. Apparently the silage deposited by the distributor was close to the wall at the bottom but the rings became smaller as the silage approached the discharge circle of the distributor.

An interesting possibility suggests itself when examining this diagram. If the distributor could be made to deposit the silage against the wall from bottom to top with the greatest density, at any level, occurring in contact with the

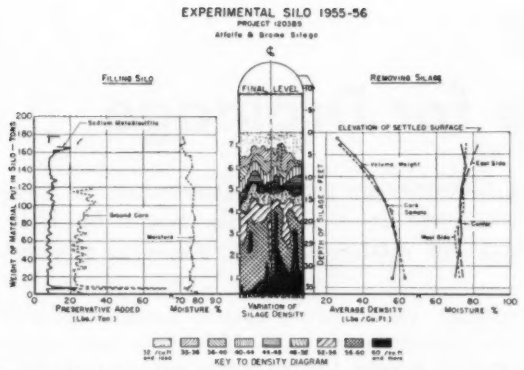


Fig. 13 Mechanical distribution of a green crop having a uniform moisture content gives a density pattern with increasing density from top to bottom. Good distribution is indicated by close agreement of two density curves

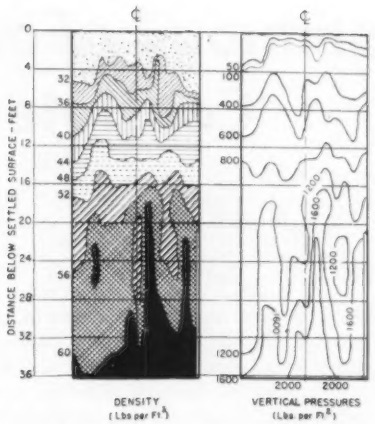


Fig. 14 By using the same silage and reproducing, in the laboratory, the density it had while in the silo, a pressure diagram was prepared. Careful inspection of density diagram reveals where the silage built up during filling

silo wall, and the lowest density near the center of the silo, a situation would be set up that would be almost ideal for a silo used for high-moisture crops. Since juice flow would follow the path of least resistance the general trend should then be for juice to flow away from the walls and toward the center. With a good drain in the bottom of the silo, less juice would get to the walls and seepage would be reduced to a minimum. The increased density at the wall would retard the passage of air at the location where air is most likely to enter. As yet there is little evidence that this can be done. Wall friction tends to make the silage less dense next to the wall and whether or not this can be overcome remains to be seen. Further study of this is in progress.

Utilizing density to indicate vertical pressure distribution within the silage mass was attempted in 1955. The samples used to determine density distribution were placed in air-tight plastic bags and brought into the laboratory. A portion of each of these samples was placed in a cylinder (Fig. 15) and compressed by a piston under air pressure until density of the sample was the same as it had been in the silo at the time the core samples were taken. The air pressure used to reproduce this density was recorded. The resulting data was plotted and lines of equal pressure were drawn. Fig. 14 shows the pressure distribution diagram plotted from this data. Comparison of this with the density diagram shows good agreement with high density material located in high pressure areas.

Springback

There has been considerable speculation concerning the amount of springback likely to occur in silage when weight is removed as the silo is emptied. Holes formed by core sampling provide a means for measuring this springback. By carefully uncovering and cleaning these holes elevations can be taken along the bottom and compared with a straight line drawn from the bottom edge of the porthole and the mark left by the sampling tube on the chute door opposite the porthole. A plot was made of one of these determinations at a level 20.2 ft below the settled surface of the silage. Springback was found to be negligible at the walls probably because of wall friction and was greatest near the center of the silo. In this case the maximum springback was approximately 3 in. Another similar determination the year before at a level 36.3 ft below the settled surface was not complete because part of the tunnel had been destroyed. Both ends were intact, however, and a plot of the data indicated springback of about 3 in, 1½ ft in from the wall on one side and a little over 3 in, 5 ft in from the opposite side. Projecting the two partial profiles it was estimated that maximum springback was approximately 4 in at a point about 1 ft from the center of the silo. It appears from this evidence that both the layer method and the surface sample method of density determination may be affected to some extent by springback.

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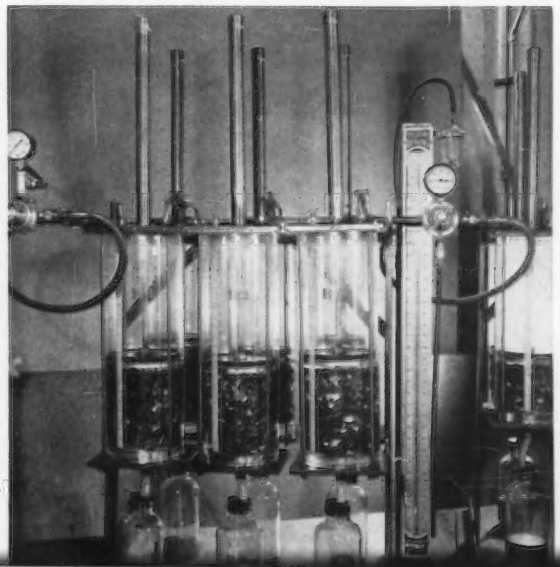


Fig. 15 Apparatus used for reproducing silage density to determine vertical pressures shown in Fig. 14

Continuously Formed Concrete Tube for Drainage

A. N. Ede

A vibration-type machine designed to lay long, unbroken tubes of permeable concrete has been used for reinforcing mole drains in England

RESEARCH on land drainage* has been in progress at Cambridge, England, in search for a low-cost method of drain installation. From preliminary field work (1, 2)† correlating the drawbar pull of moleplows with soil shear strength it was concluded that the moleplow technique was practicable for the formation of 4 in. channels at a working depth of 30 in. in heavy clay and up to 48 in. in lighter alluvial soils. The problem then was to determine whether a cheap channel stabilization material could be used with the moleplow to eliminate tile-laying operations in many soils. Concrete was selected as being a cheap, readily available material of properties which might enable it to be used direct from the mixer and to be formed in situ as a tube in one operation sequence.

The investigation proceeded on the lines that the final product should be mechanically strong, erosion resistant and able to conduct water through the walls. Laboratory studies were first involved with the problems of conveying concrete down the narrow space allowed by the moleplow blade, and of achieving permeability and stability as a tube. The results indicate that the concrete may be considered for drainage work as being of two main types, according to whether at the mixing stage it is saturated or unsaturated with water. The difficulty in using the saturated type is discussed, in a recent paper (1). This article deals with the unsaturated concrete, referred to here as dry-mix concrete.

Paper prepared expressly for AGRICULTURAL ENGINEERING.

*Research sponsored by the Agricultural Research Council and carried out at the School of Agriculture, Cambridge, from 1952 to 1957.

†Numbers in parentheses refer to the appended references.

The author—A. N. EDE—is senior scientific officer, A.R.C. Unit of Soil Physics, University of Cambridge, Cambridge, England.

Acknowledgments: Drawings of the machine have been copyrighted by FARM MECHANIZATION and were printed with permission.

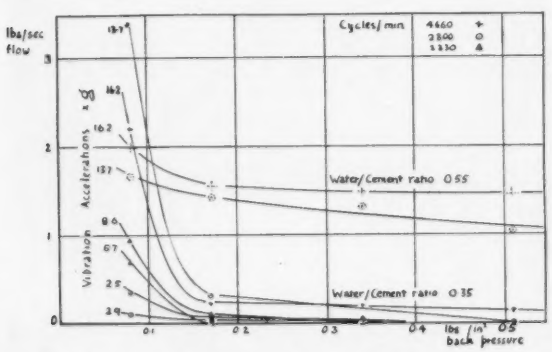


Fig. 1 Performance of a vibrating vertical duct of section 8 in. x ¾ in., transmitting from a hopper against an outlet back pressure concrete made from ⅜ in. graded aggregate. The aggregate-to-cement ratio by weight is 5

Flow Along the Blade

In dry-mix concretes the forces on the material are transmitted by particle contact. Theory and experiment concerning the mechanics of pumping (3) show that direct pressure is useless for attempting to force the concrete through a narrow duct to the mole channel, since pipeline pressures increase exponentially with distance pumped. The vertical position of the blade makes possible the use of an alternative method of feed whereby the duct itself is given a vertical vibration movement to assist gravity. Laboratory apparatus arranged to test the flow through a flat duct leading from an overhead hopper against an outlet pressure at the foot yielded the results shown in Fig. 1. The flow, in general, responds linearly to the maximum acceleration experienced in the vibration; the accelerations were obtained at various amplitudes and frequencies. The sensitivity of the dry-mix to the application of a blocking back pressure at the outlet is a fundamental factor in its use and is in contrast to the behavior of the more liquid mix at intense vibrations. From this test it was concluded that a flow of about 120 lb per min could be relied upon at the lowest back pressure with intense vibration, giving a rate of supply equivalent to 30 ft of concrete tube material per minute weighing 4 lb per foot. This performance was considered satisfactory. In practice a vibration of frequency 2700 cycles per min and amplitude 0.03 to 0.05 in. proved to be suitable.

A practical point which developed concerned the concrete stored in the supply hopper. It is essential to keep this stirred continuously to ensure free entry to the vibrating duct. The duct itself must be constructed of ripple-free plate, and riveting of the side plates is preferred to welding for this reason.

Formation of Permeable and Stable Tube

Laboratory measurements of permeability have been made on numerous samples of concrete to select those likely to exceed the permeability of the more common soils. Concrete can be made as permeable as the objective of 0.01 cm per sec (14 in. per hr) by eliminating fine sand from the aggregate and by keeping the mix dry enough. The trends of permeability in Table 1 indicate that for a given maximum size of aggregate high permeabilities are favored by coarsely graded material, by low contents of fines, water, and cement, and by combinations of these factors. In practice it was found possible to obtain satisfactory permeability on the site without losing durability qualities, so far as is known, by use of easily obtained materials.

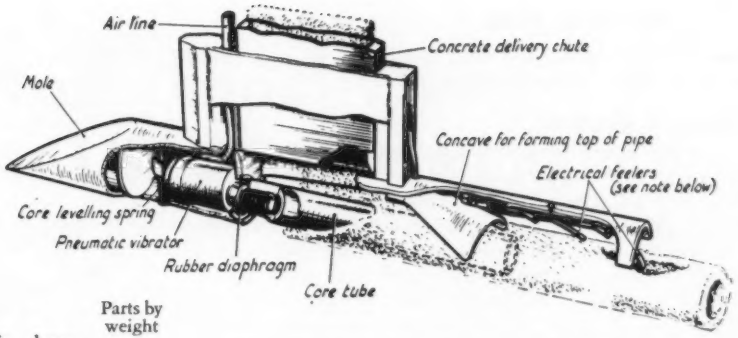


Fig. 2 Cut-away section of the mole and the foot of the blade. If a faulty tube is made, the spring feelers are allowed to fall by the concrete and an electrical signal gives warning to the operator (FARM MECHANIZATION)

	Parts by weight
Aggregate, graded from 3/16 in. or 1/8 in. down to 25 sieve size	100
Cement (Portland)	20
Water	6-8

The proportions are not critical, and mixes have been used at aggregate-to-cement ratios (A/C) varying from 3 to 50. It is possible to gauge the water-to-cement ratios (W/C) or moisture content by eye at the mixing stage, to compensate for aggregate dampness, and a useful check for the operator is to cease adding water to the mix when a sample squeezed in the hand will just retain its shape on release.

The strength(2) of dry-mix concrete in the fresh state is improved by thorough consolidation. Since it is shown in Fig. 1 that there is little feed pressure available, the compaction of the material to the section of a tube in the mole channel must be assisted. Mechanical tamping or packing is possible, and has been tried in the past (4), but the method used in this work is to apply a vibration to the material by means of the core in the mole channel around which the concrete tube is formed (Fig. 2). The material arriving from the duct is first broken down by the vibration, settles to the floor of the channel under the vibratory action, and is progressively reformed to the desired section. In the later stages a concave plate over the tube presses down on the still-consolidating material, and a roof structure is produced which immediately is able to support itself as the machine moves on. This process does not rely on any rapid-hardening qualities in the cement.

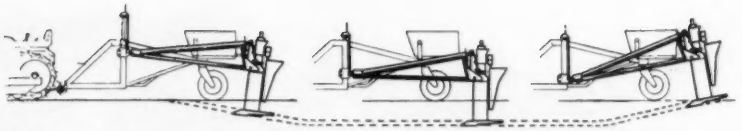
TABLE 1. PERMEABILITY OF VARIOUS CONCRETE MIXTURES

Variable	Main aggregate grading	Fines passing 25 sieve added as percent of total	A/C (by weight)	W/C (by weight)	Permeability cm per sec
Effect of increased fines	Passing 3/8 in. and retained on 25 sieve (nomenclature 3/8 in.-25)	0	5	0.60	0.036
		10	5	0.60	0.023
		20	5	0.60	0.015
		30	5	0.60	0
Less coarse grading	3/8 in.-25 with 82% 3/8 in.-3/16 in.	—	5	0.45	0.071
	3/8 in.-25 with 68% 3/8 in.-3/16 in.	—	5	0.45	0.049
	3/8 in.-25 with 35% 3/8 in.-3/16 in.	—	5	0.45	0.009
Increased cement content	3/8 in.-25	25	10	0.50	0.031
		25	5	0.50	0.003
		25	3	0.50	0
Increased water content	3/8 in.-25	25	5	0.30	0.040
		25	5	0.40	0.013
		25	5	0.50	0.003
	3/16-25	0	5	0.35	0.042

Preferably the core should be mounted flexibly, in order to follow a path on the axis of the mole channel, but it should also be spring depressed to compensate for flotation. The vibration unit has to provide a high frequency (5000 to 6000 cycles per min) movement which is entirely axial, and a free piston pneumatic vibrator has been found to be most satisfactory. Radial vibration causes buffeting to the newly-formed tube and should be avoided. The mole is progressively cut away at the sides to allow contact by the soil with the consolidated portion of material, and the tube is held by

Fig. 3 The drainage machine, drawn by a heavy tracklaying tractor with the mole entering the soil

the soil at the bottom and sides, and 1 in. clear space is allowed over the roof.



Design of Machine

A heavy tracklaying tractor fitted with a low-speed gear is used to haul the semi-trailed drainer at a speed of 8 ft per min (Fig. 3). The tubular steel chassis carries a 12-hp gasoline engine driving the pneumatic and hydraulic auxiliaries. Within the frame the moleplow 11-ft beam rides with a floating action maintaining the blade depth solely by the vertical position of its hydraulically controlled front end pivot (Fig. 4). This in turn is kept lined up by sighting on distant level markers in the field.

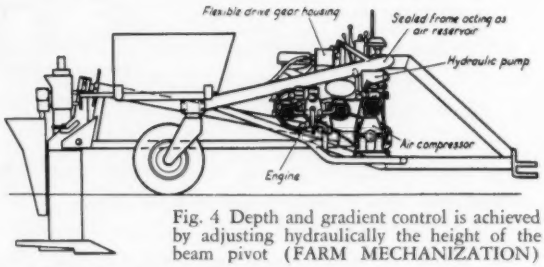


Fig. 4 Depth and gradient control is achieved by adjusting hydraulically the height of the beam pivot (FARM MECHANIZATION)

Concrete and gravel supplies are held in two 1½-ton hoppers for feeding by hand to the respective small hoppers on the blade itself. This is of welded steel construction (Fig. 5), and houses internally the pneumatically vibrated vertical duct for the concrete. At the rear of the blade is a lightly constructed chute which is used for filling the blade slit with gravel in clay land. This is to give access for water to the drain and to avoid partial crushing of the mole channel due to closure of the slit. In light land an inclined plate at the rear of the blade is used to press soil downward to close the slit as a substitute for a gravel fill.

The blade measures in cross section 1½ in. x 18 in., and is fitted with a mole of depth 5 in. and width 4 in. The core vibrator is housed in the nose of the mole, and is actuated by an airline passing down a separate internal passage in the blade. The air from the vibrator exhausts through the core tube into the concrete drain. The concrete drain measures 4-in. diameter externally and from 1½ in. to 2¾ in. internally according to core size.

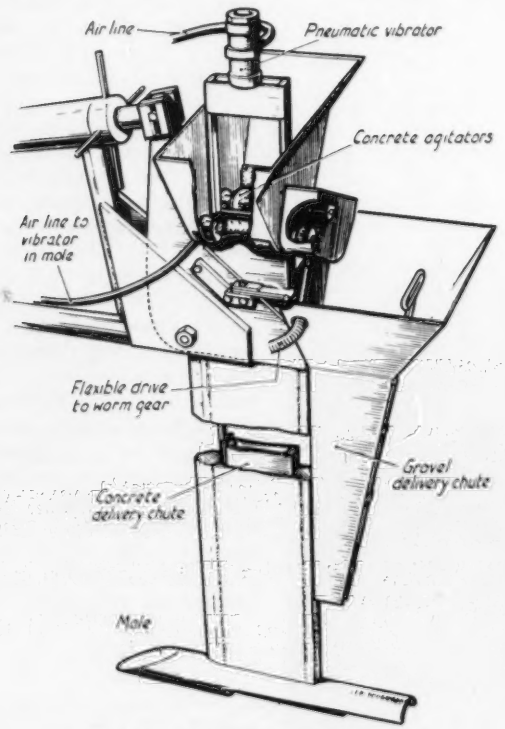


Fig. 5 Main features of the moleplow blade (FARM MECHANIZATION)

Field Performance

Much of the initial mechanical testing has been carried out in a sand tank on the surface, which enabled tubes made at various speeds to be compared quickly for strength and continuity (Fig. 6). In field soils as a supplement to inspection of tubes by digging a fault warning system was used (Fig. 2) recording discontinuities in the roof of the tube on a chart against ground position, speed, depth, pivot height and drawbar pull. Faults in tube manufacture are associated with a lack of self-cleaning action on the core tube. For continuous working core sizes of 1½ in. or 2-in. give satisfactory results, but larger sizes of core used with the present design require the implement to be withdrawn occasionally for cleaning. The machine has been used to lay down full-scale field drainage systems which are under observation. Beyond the restriction that drains cannot be laid below the water table, no overriding difficulties have been met, and the drains installed in heavy land in time for the winter season have functioned satisfactorily.

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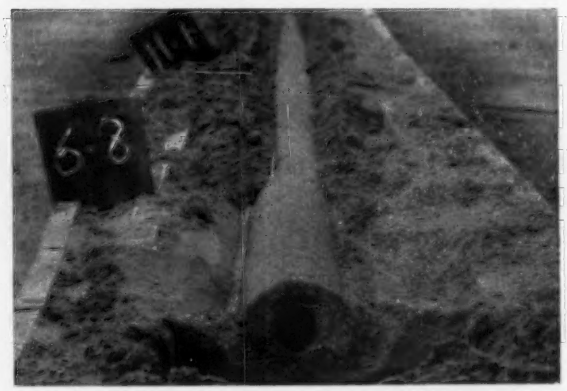

Fig. 6 Concrete tube formed in a surface testing trough at speeds of 6.8, 11.1 and 18.2 fpm

INSTRUMENT NEWS

Design of a Proportional Weir for Use in a Flowmeter

D. F. Witherspoon and F. R. Hore
Assoc. Member ASAE Member ASAE

IN TILE drainage investigations that require a relatively accurate measurement of small amounts of drain effluent, complicated and expensive equipment has been used. Childs (1)* developed a simple, inexpensive flowmeter which is being manufactured commercially by C. F. Casella and Co. The rate measuring device used by Childs in the flowmeter was an orifice plate. This consisted of an ebonite plate drilled with small circular orifices so arranged to provide an approximate straight line relationship between head and discharge. Tedious calculations which are necessary when discharge is a power function of the head are thus eliminated.

This type of meter was selected to measure tile-drain effluent at two study sites in Ontario. It was found, however, that orifices larger than those used by Childs were required to accommodate the expected maximum flow. These large orifices weakened the plate and caused interference and distortion of the flow at the vena contracta. In addition an error was found inherent in the use of orifices since the head-discharge relationship only approached a straight line.

*Numbers in parentheses refer to the appended references.

Paper prepared expressly for AGRICULTURAL ENGINEERING.

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INSTRUMENT NEWS (Karl Norris, Editor) is sponsored by the ASAE Committee on Instrumentation and Controls. Contributions on agricultural applications of instruments and controls and related problems are invited, and should be submitted direct to K. H. Norris, 105A South Wing, Administration Bldg., Plant Industry Station, Beltsville, Md.

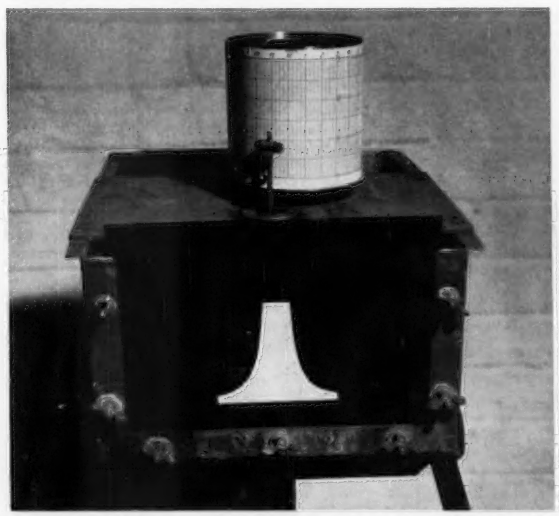

Fig. 1 A Casella flowmeter equipped with a 2½-in. Rettger proportional weir

To overcome these disadvantages, a Rettger proportional flow weir, shown in Fig. 1, was used. These weirs are used as velocity control devices in sewage treatment hydraulics (2). Rettger (3) has shown that a proportional weir having a horizontal crest and sides formed of curves given by the equation:

$$2XY^{\frac{1}{2}}=K \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

results in the theoretical flow equation

$$Q=K\ (\pi/2)\ \sqrt{2g}\,H \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

By the introduction of the coefficient of discharge, C, the theoretical equation becomes the empirical equation of discharge,

$$Q=CK\ (\pi/2)\ \sqrt{2g}\,H \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [3]$$

where Q = discharge (cfs)
H = depth of flow above the weir crest (ft)
K = weir constant
C = coefficient of discharge.

Experimental values of the coefficient of discharge, C, were determined for two sizes of proportional weirs. For the weir with a maximum capacity of 0.01 cfs, $C=0.64$, and for the weir with a maximum capacity of 0.04 cfs, $C=0.66$. These values compare favorably with the value of 0.65 found in tests cited in (2). The weir constant K may be computed after the maximum values of Q and H and the coefficient of discharge, C, have been selected.

During the spring of 1956 two flowmeters equipped with 0.04 cfs capacity weirs were installed in the field. Fig. 2 shows one of these installations. It was found that the performance of these weirs was satisfactory in the field.

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Fig. 2 A field view of the flowmeter installation at the end of a tile drain

This column contains letters in which our readers have expressed opinions, suggestions, unusual experiences, or divergent views on subjects of an agricultural engineering nature. It is the intention of the editor to publish a few such letters in each issue of AGRICULTURAL ENGINEERING to encourage free expressions and open debate on pertinent and timely topics.

"Needed: A Substitute for a Team of Mules"

TO THE EDITOR:

There have been some interesting responses to my article, entitled "Needed: A Substitute for a Team of Mules" in the March, 1957, issue of AGRICULTURAL ENGINEERING. Two or three of these are from tractor manufacturers, a few from parts makers and the majority from men connected with agricultural colleges.

I am confident that progress will be made to supply a utility tractor and simple machines to sell substantially below the prices of today's equipment. This simplified line will not replace more highly refined and equipped power machines, but will find a different market and will to some extent supplement the more costly equipment.

The small or low-income farm offers a challenge which goes beyond the cost of machinery although this is one of the factors. There are people, and among them are certain spokesmen for agriculture, who would remove this type of farmer from the land or have him starve. However, he is not likely to do either. There is not only a place for him in our social structure, but I am inclined to think that he will succeed in improving on his economy and way of life to a point where he will become an important stabilizing factor in our national life. This is not to say that all the hillbillies are going to find themselves in any sort of utopia in a short time. It would be a mistake to try to change these conditions too quickly.

It is important to realize that we are dealing not so much with a type of people as with a type of land, and we just haven't learned the best way to manage poor land. By and large, the "poor farmer" we are talking about is living on "poor" (unproductive) land. This land could not support the investment in equipment and methods used on productive farms regardless of the ability of the operator. Most of our farm technology and thinking have been developed to fit the large productive farms. Likewise, very little of the 5 billion dollars for annual farm aid and price supports have benefited the small farmer.

Some months ago there was started a so-called rural development program which may do some good. Dean Reed, formerly of Purdue University, has recently been appointed to head this program. He is an able man, and I am sure he knows the limitations and dangers inherent in government "planning." Nevertheless, the program has tremendous political implications and this is likely to be seized upon at the propitious time by eager politicians and bureaucrats.

There is every reason to believe that the situation will be worked out, without federal government planning, by individual ingenuity and effort when once some practical patterns have been established and have become publicized. The men I have talked with in agricultural colleges, especially in the southeastern states, are well aware of the problems confronting the small farm family. They are the people best qualified to guide and administer any service in this field. The special functions of the agricultural college—research, education, and extension — cover a wide front and, by and large, these services have done great work in agriculture. It is better, in my opinion, to add to and broaden their functions than to create or develop new agencies to parallel or subvert them.

There are a number of approaches which, in my opinion, would be helpful. None of them is exactly new except the last one which I shall mention. They are as follows:

1 New practices and land-use ideas are needed to better fit this type of farm, and these may be quite different from those to which we are accustomed. This may include new or better adapted crops, more specialties, different livestock management, etc.

2 Neighborhood rings or local corporations to own the necessary operating equipment — at least the costlier units — and to provide competent operation. In some localities this may include sawmill, trucks, etc. Such corporations would be operated on a business basis and owned by the local people being served.

3 The encouragement of local industry to provide off-farm employment. Certainly a number of small or local industries would be preferable to a few large ones. The opportunity for industry of local adaptation in this field is great and this is bound to become better recognized in the future.

4 Recognition for the achievements and abilities of local people. Contests by counties and statewide would help to accomplish this. Broadly speaking, they would be based on, say, "Success on a 40-acre hillside farm." They would take into consideration the farm operation, the home, off-farm income and other factors which enable the family to make a go of it.

Some of these people are surprisingly resourceful and self-sufficient. It is important that this resourcefulness and experience should be capitalized. Sound progress is more likely to grow from the grass roots than from any other direction. Such contests would not have to involve much expenditure, but they would have to have the right kind of support to get publicity and achieve the desired educational impact. It is conceivable the agricultural extension service would sponsor such contests. At any rate its cooperation would be essential.

I expect to discuss this further with some of the people who have expressed interest in these problems. This is an area which should provide a fertile field for agricultural engineers, not only as to farm equipment and methods for its economic ownership and use but also as to agricultural processing or other industry of local adaptation.

G. B. GUNLOGSON

Racine, Wisconsin

Subirrigation System Design

TO THE EDITOR:

This is in reply to Mr. Herman Bouwer's letter published in the Readers' Forum of the March, 1957, issue of AGRICULTURAL ENGINEERING. Mr. Bouwer in his contribution has taken exception to some of the assumptions and simplifications included in the article, "Design of Subirrigation Systems," which appeared in the February, 1956, issue.

As noted in Mr. Bouwer's letter, there are two problems in which he and the authors hold somewhat divergent viewpoints. We, as authors, present as follows, in the same order previously utilized, our opinions concerning the two items at issue:

The possibility of the existence of a phreatic surface at some distance below the bottom of the irrigation ditches at steady state.

As we interpret them, the essence of Mr. Bouwer's comments on this item is that an unsaturated zone would not exist under a subirrigation ditch at a steady state and consequently the phreatic line must intersect the water surface in the feeder ditch. In support of his opinion he presents in paragraph 2 and Fig. 2 (his letter), a hypothetical unsteady state analysis beginning with a feeder ditch in operation during a rainfall of sufficient magnitude to raise a desirable water table up to the water surface in the ditches, at the ditches, and then proceeding to a steady state condition without the phreatic line breaking away from the ditch water surface.

It is our intent to maintain the water table at near optimum depth below the ground surface by applying only the amount of water to satisfy the consumptive use requirement u plus that amount which will flow out of the area through subsurface flow. Under these conditions, the total available energy head (measured from the water surface in the ditch to the water table midway between the ditches) could be in excess of the d actually required to deliver the necessary amount of water longitudinally to the area. In this case, the phreatic line could and would drop below the bottom of the feeder ditch. As noted by Mr. Bouwer in his comment No. 4, such tensions and unsaturated zones have been observed under irrigation canals. We also have observed this unsaturated condition beneath ditches on subirrigated lands served by regular systems.

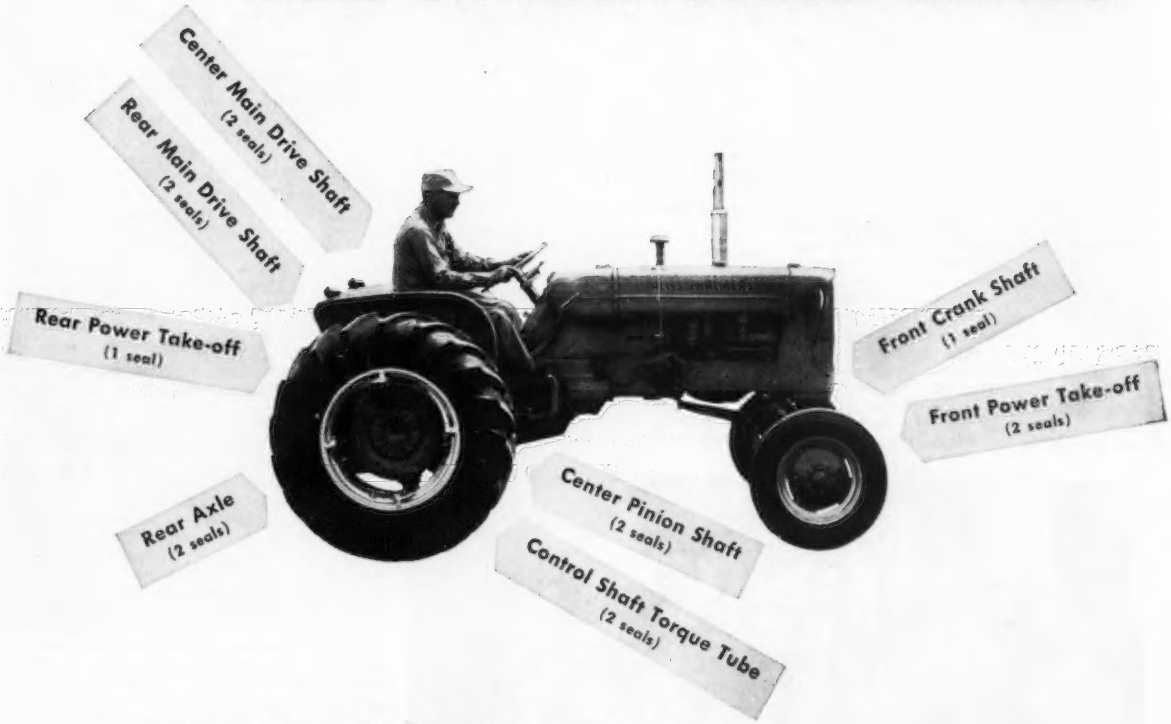
It is important to understand that for a given crop there is a depth below which the water table should not be allowed to drop if optimum crop growth is to be obtained. Furthermore, there is a lesser depth which is the upper level to which the water table may be allowed to rise if crop response is not to be affected by waterlogging. These recommended depths vary widely with crops, soils and climate.

In order to keep the water table within the optimum range for a given crop under conditions as they exist in the field of varying u factors due to changing weather and stages of crop growth, it becomes necessary to apply water at varying rates and from a practical standpoint at alternating intervals. This fact alone makes an anlysis at a steady state only a selective design procedure, of value primarily for selecting a reasonable ditch spacing.

In our opinion, proper management of land being subirrigated by open ditches requires that the system have sufficient capacity to rapidly raise the water table at the beginning of the growing season and to maintain the water table during peak demand periods without the necessity of the feeder ditches being in continual operation. Constant operation has the undesirable effect of promoting weed growth and reduc-

(Continued on page 876)

NEW! LOOK AT THE 14 POINTS WHERE ALLIS-CHALMERS D-14 TRACTOR RELIES ON NATIONAL SEALS



At 5 positions in the new D-14, Allis-Chalmers specifies steel-encased, spring-tensioned National leather oil seals. Two additional positions employ steel-encased, spring-tensioned Syntech® synthetic rubber seals. At still another position, the control shaft torque tube, a springless rubber-covered National Syntech is used.

All National seals in the D-14 (and many in Allis-Chalmers' equally new D-17 tractor) are standard design National seals. National supplies over 2,500 different types and sizes of oil seals, leather or synthetic. New seals are being designed daily to meet special applications.

For factual, professional engineering help on any shaft sealing problem, call your National Applications Engineer. He's listed in the Yellow Pages, under "Oil Seals—National Seal Division." He's backed up by 36 years of sealing experience, and the productive capacity of three modern plants.

NATIONAL SEAL Division, Federal-Mogul-Bower Bearings, Inc.

General Offices: Redwood City, California; Plants: Van Wert, Ohio, Downey and Redwood City, California 4589

For more facts circle No. 14 on reply card

Winter Meeting Features

The Honorable George D. Clyde, Governor of the State of Utah, will speak on reclamation and the agricultural surplus during the general session on Tuesday afternoon, December 17, at the Winter Meeting in Chicago.

Mr. Clyde is the son of a pioneer Utah family. His father was a pioneer irrigation farmer on one of the early reclamation projects (Strawberry Valley Project). His early years were spent on an irrigated farm amidst the trials and problems of making a productive farm out of a desert. Irrigation was a part of the farm job and the shovel and the lantern were tools as common as the plow and the hoe.

He received a B.S. degree in agricultural engineering from the Utah State Agricultural College in 1921 and an M.S. degree in civil engineering from the University of California in 1923. He has held membership in the American Society of Agricultural Engineers, American Society of Civil Engineers, Soil Conservation Society of America and the Western Snow Conference.

Mr. Clyde has traveled over the United States and is familiar with the irrigated areas and irrigation projects, both federal and private, in the Western States. He is familiar with the major river basins, the current developments in them and their potential soil and water resources.

The program will also include other noted speakers. Dr. Glenn Murphy, professor and head, department of theoretical and applied mechanics, Iowa State College, will speak on the applications of similitude theory to agricultural engineering research; and Dr. Henry E. Bent, dean of graduate school, University of Missouri, Columbia, will talk on fundamental research—pinnacle or foundation. The final topic for the afternoon will be on industrial research and will be presented by Dr. C. E. Barthel, Jr., assistant director, Armour Research Foundation, Illinois Institute of Technology, Chicago.

Farm Structures Division Milker

This special session will be held Monday afternoon, December 16, starting with a get-acquainted time at 4:15. A movie called "The Salesman" will be shown and a talk entitled "Peanuts" will be given by Cloyd Steinmetz, director of sales training, Reynolds Metals Co. A dairy smorgasbuffet will be served at 5:30.

Special Evening Features

Two concurrent special program features are scheduled for Monday evening, Dec. 16.

Farm Work Efficiency Program — C. R. Olson, chairman of the committee on farm work efficiency, will preside. Subjects to be discussed will be on energy expenditure and farm work efficiency, by W. H. M. Morris, Purdue University; vibration as a psychological factor in work efficiency, by M. Schmitz, Bostrom Mfg. Co.; and sociological aspects of farm work efficiency, by R. L. Eichorn, Purdue University.

Extension Brainstorming Session — The chairman of the committee on extension, F. W. Andrew, will conduct this meeting. A demonstration of the technique of brainstorming, or creative thinking by groups, will be led by Joseph A. Hopkins of the Ethyl Corp. This demonstration will show how to stimulate people to develop new ideas and put them to work.

ASAE MEETINGS CALENDAR

December 15-18—WINTER MEETING, Edgewater Beach Hotel, Chicago, Ill.

January 10 — WASHINGTON, D.C. SECTION, USDA, South Bldg., Washington, D.C.

January 30-31 — PACIFIC COAST SECTION, University of California, Los Angeles, Calif.

February 3-5—SOUTHEAST-SOUTHWEST SECTION meeting, Little Rock, Ark.

February 14—WASHINGTON, D. C. SECTION, USDA, South Bldg., Washington, D. C.

March 28-29 — ROCKY MOUNTAIN SECTION, Engineering Center, Colorado State University, Fort Collins, Colo.

June 22-25 — 51st Annual Meeting, Santa Barbara Campus, University of California, Santa Barbara, Calif.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Mark 25th Anniversary

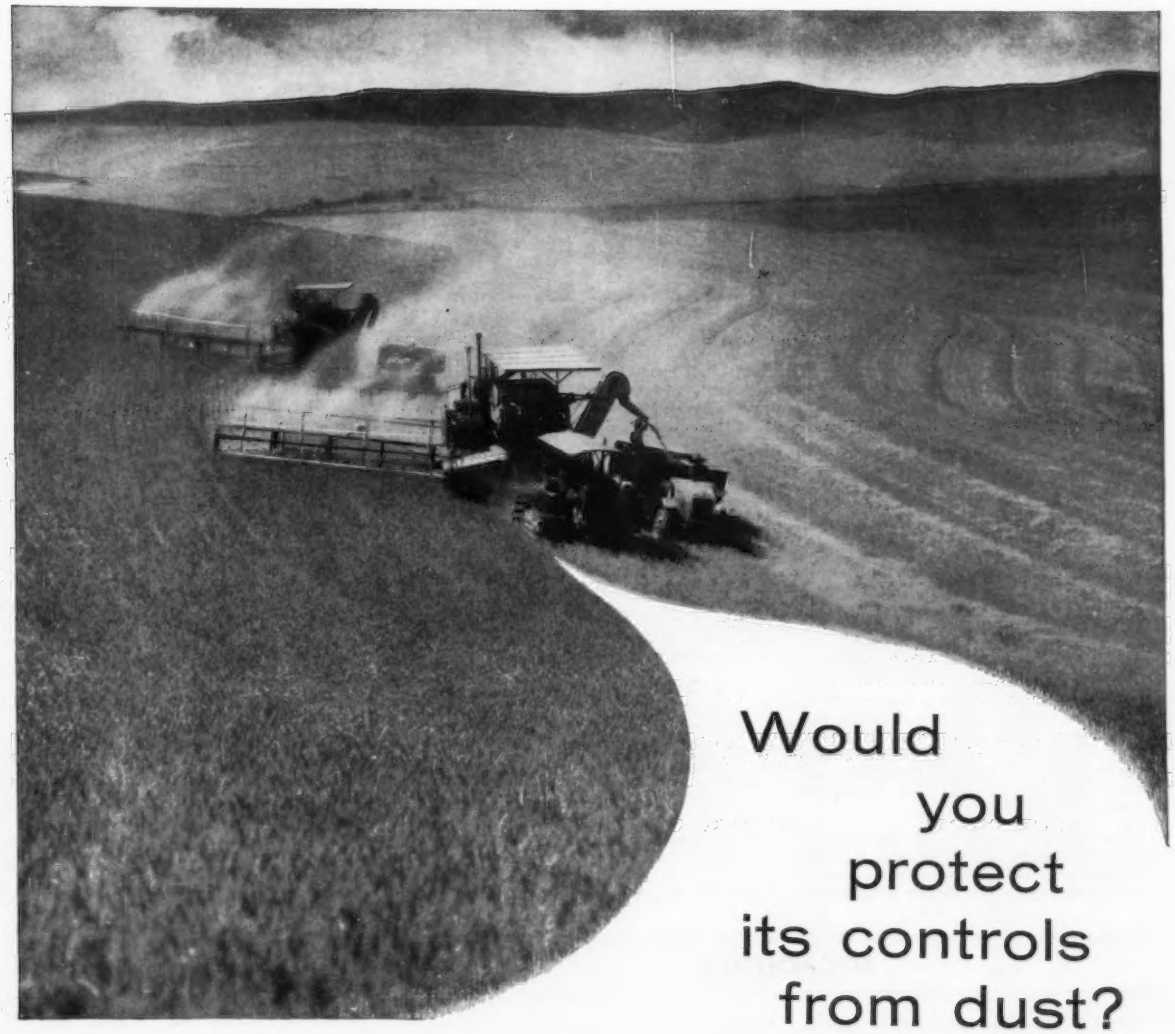
Open house and a homecoming banquet marked the 25th anniversary of the establishment of an agricultural engineering curriculum at the University of Illinois College of Agriculture on Friday and Saturday, October 18 and 19. Featured speaker at the Friday evening banquet was Earl D. Anderson, president of ASAE. In his address, "A New Benchmark," he traced the history of the department. He praised the department on its past performance and gave the following points as inspiration for still greater accomplishment: *(a)* strengthen the staff since great men are the University's most vital asset; *(b)* maintain a strong, but flexible curriculum; *(c)* establish and maintain high standards of instruction in the so-called service courses, *(d)* build a strong graduate program leading to the doctorate; *(e)* strengthen the relationships with other sections of the experiment station; and *(f)* provide improved physical facilities.

Saturday morning included a tractor tipping demonstration and conducted tours of more than 30 special exhibits in the agricultural engineering laboratory and classroom building.

(Continued on page 892)

(Above) The ASAE Research Conference Committee held a meeting in Beltsville, Md., September 19 and 20, to discuss electrification research activities and plans of the United States Department of Agriculture. Those attending were *(left to right, front row)* J. C. Cahill, J. P. Ditchman, W. J. Ridout, Barton Reynolds; *(second row)* J. P. Schaenzer, H. H. Beaty, Dean Searles, T. E. Hienton; *(third row)* E. G. McKibben, E. T. Swink, Price Hobgood, L. J. Endahl; *(fourth row)* H. S. Pringle, Hobart Beresford

(Right) James Curtis, assistant professor, *(left)* points out strength features of the new "do-it-yourself" farm building aluminum roof to E. L. Hansen, professor of agricultural engineering at the University of Illinois. This was one of the many projects on display Friday and Saturday, October 18 and 19, as the agricultural engineering department of the University of Illinois observed its silver anniversary



Would you protect its controls from dust?

Call it dirt, call it dust, call it chaff . . . call it whatever you like—agricultural machinery is never free of it. That, plus the fact that when agricultural machinery is needed, it's needed *now*, makes protection against contamination a crucial consideration in designing agricultural equipment.

Breakdowns spell disaster in this seasonal business. That's why you would never let a tractor out of the plant without filters. And that's why today's increasingly complex machines need the same protection for their sensitive controls. A hydraulic line on a grain combine, for example, can be stopped cold by a speck of grain, a piece of dirt, or one of scores of particles that cloud the air during normal farming operation. But particles as small as .000039 inch will be removed if you design Purolator filters into your control systems.

The controlled porosity of Purolator's Micronic element accounts for this unbeatable efficiency. The Micronic element is not affected by high temperatures, water, or oil. It is available in standard filters from Purolator's stock of over 2000 models.

Get complete information from Purolator's 32-page "Filtration Manual for Product Designers". Enclose 25¢ to cover postage and handling. Address Dept. AG-631.

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For more facts circle No. 15 on reply card

H. W. LUDWIG

L. S. PFOST

D. B. KRIMGOLD

LUIS E. MORCILLO

Howard W. Ludwig has been appointed sales manager for the Bearings Company of America Div., Federal-Mogul-Bower Bearings, Inc. He had been associated with Bower Roller Bearing Co. for about 25 years and served in many manufacturing and sales positions. Since Bower became a division of Federal-Mogul-Bower Bearings, Inc., he has been automotive original equipment sales engineer.

Lester S. Pfost, former chief engineer of the tractor division, Massey-Harris-Ferguson, Inc., has been appointed to a sales engineering position on the staff of the agricultural engine division of Continental Motors Corp. in Muskegon, Mich. Mr. Pfost joined Massey-Harris-Ferguson in 1920, and since 1936 has had charge of all tractor design, experimental and field testing. He was made executive engineer in 1955.

Dov B. Krimgold has returned to Israel to serve as FAO hydrologist, Soil Conservation Division, Ministry of Agriculture, Hakirya Tel Aviv, Israel, until the end of 1959. Prior to his new assignment he was principal research scientist, Laboratory of Climatology at Buckhorn Farm, Woodbine, Maryland.

Luis E. Morcillo has been appointed as dean of the faculty of the Escuela Agricola Panamericana in Tegucigalpa, Honduras. In 1939 he received a B.S. degree in agronomy from the Faculty of Agronomy in Cali, Colombia and in 1956 he earned an M.S. degree in agricultural engineering at Michigan State University. He returned to Escuela Agricola Panamericana as professor and head of the agricultural engineering dept.

Merrill J. Anderson has been appointed an automotive and agricultural engineer in the eastern region of Ethyl Corp. sales dept. He will make his headquarters in New York. For the past 18 years he has been associated with the Detroit research and development laboratories of the Ethyl Corp. He has been active in many research projects in the diesel and gasoline engine fields.

J. E. Christensen resigned July 1, 1957, as dean of the school of engineering and technology at Utah State College and obtained a leave of absence for one year. He spent three months in Uruguay for FAO as irrigation engineer to assist the Government in the development of water resources for irrigation. During the school year he is visiting professor of irrigation at the University of California, Davis. Next fall Mr. Christensen plans to return to Utah State University as professor of civil engineering.

Morris E. Schroeder joined the agricultural engineering staff of the Pennsylvania State University to assume teaching and research duties in farm machinery. He had worked as an extension agricultural engineer in Pennsylvania and has returned to the University after a year of graduate study at Purdue University.

Maurice W. Brandt, formerly research technician at Michigan State University, has accepted employment with the Blackmer Pump Co. of Grand Rapids, Mich.

George A. Crabb, Jr., formerly hydraulic engineer with Portland Cement Assn., has accepted a position as hydrologist for the Baker-Harza Engineering Co., Amman, The Hashemite Kingdom of Jordan. The company has contracts with the Kingdom for engineering services in connection with the development of small waters for irrigation purposes. Mr. Crabb's work is in the eastern desert and around the Dead Sea. He reports that in this land water is not just wealth, but life itself.

Philip F. Wendell has resigned his position as chief engineer, American Planter Co., to become associated with Wisler Engineering, Inc., Burr Oak, Mich. The company deals in the design, engineering, development and manufacturing of industrial processing and agricultural field and processing equipment.

Arthur J. Schwantes, past-president, Fellow of ASAE and head of the agricultural engineering department at the University of Minnesota, was elected a member of the board of directors of the National Safety Council. He was also named chairman of the Farm Conference of the Council.

Mr. Schwantes joined the University staff in 1921 and has been the head of the agricultural engineering department for 17 years. He is a specialist in farm power and machinery and farm safety. The National Safety Council represents industrial firms, public agencies and other organizations and is designed to promote safety education and safety practices.

N. Sankaranarayana Reddy, assistant agricultural engineer, Agricultural College, Coimbatore, S. India, has been chosen by the Government of India to take advanced training in agricultural engineering at the University of Tennessee, under the United States aid program to India. He will be studying at the University for 12 months.

Marc G. Davenport, formerly assistant professor in research at the Texas Agricultural Experiment Station, College Station, has accepted a position as senior project engineer with the Lilliston Implement Co., Albany, Ga. His duties will include responsibility for engineering of the company's line of pasture mowers and shredders.

NECROLOGY

Ivan G. Morrison, professor of agricultural education at Purdue University, died of a heart attack at his home in West Lafayette, Ind., last June.

He was born at Fairbury, Ill., in 1893. He graduated from the University of Illinois in 1917 with a B.S. degree in agriculture. He immediately entered the armed forces and served in the Army Air Force in France during World War I. After the war he farmed for several years and taught vocational agriculture for eight years at Argenta, Ill. In 1934 he entered Cornell University as an assistant in the agricultural engineering department and began graduate study in agricultural engineering and agricultural education. He graduated in 1936 with an M.S. degree. That same year he became assistant professor of agricultural education at Purdue University. He was promoted to associate professor in 1940 and became a full professor in 1945.

Mr. Morrison taught courses in farm mechanics at Purdue University for prospective teachers of vocational agriculture for approximately ten years. He was on leave of absence for six months during World War II to serve as a consultant in farm mechanics education for the U.S. Office of Education, and a second six months to serve as a consultant in industry.

He was a pioneer in the development of instruction in respect to preventive maintenance work and repair of tractors and other farm machinery by teachers of vocational agriculture. He was the author of two books, "Repairing Farm Machinery" and "Farm Tractor Maintenance," as well as numerous professional articles, bulletins and various types of teaching aids for teachers of vocational agriculture.

Mr. Morrison was a member of the Presbyterian Church, the Masonic Lodge, the American Legion, and several professional organizations in the fields of agricultural engineering and education.

Arthur J. Bell, former extension specialist in agricultural engineering at Michigan State University, died of a heart attack, November 9, at his home in Benzonia, Mich.

He was born at Lansing, Mich., in 1893. In 1924 he graduated from Michigan State University with a B.S. degree. He joined the MSU Cooperative Extension Service in 1927 and retired July 1, 1955, after 28 years of service.

Mr. Bell was known throughout the state for his work with farmers in farm structures and machinery. He also helped develop and popularize laminated rafter construction for farm buildings. He was the author of several bulletins on farm machinery and has written several magazine articles on farm drainage and water systems on farms.

NEW

Tachometer Take-Off

...for VEEDER-ROOT Rev-Counters

With this new attachment, Veeder-Root Rev-Counters can be installed on any engine having a tachometer take-off in a position which is readily accessible for easy reading. Take-off can be furnished to suit average engine-speed.

So now you can make it easier than ever for your customers to see that your product is performing up to its guarantee . . . to see when routine maintenance is coming due, and whether servicing is needed.

You can count on Veeder-Root to figure out how to engineer these adaptable Rev-Counters into *your* products . . . not only engines, but generators, compressors, heaters, refrigerators, and what have you? Write:

Everyone... Can Count on

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New York 19, N. Y.
Greenville, S. C. • Chicago 6, Ill.
Montreal 2, Canada
Offices and Agents in Principal Cities

For more facts circle No. 31 on reply card

MANUFACTURERS' LITERATURE

Shear Pin Sprockets

Link-Belt Company — Folder 2749 gives information and tables listing stock sizes, torque ratings, hub dimensions, and keyseats of the company's shear pin sprockets. Examples for selection, and problem and solution instructions are included.

(For more facts circle No. 51 on reply card)

Milking Parlor Stalls

Babson Bros. Co. — A folder prepared to help a dairyman select parlor equipment which best suits his needs. It discusses the advantages of diagonal stalls versus in-line stalls.

(For more facts circle No. 52 on reply card)

Instruments for Pesticides

Beckman/Scientific Instruments Div.—An 8-page illustrated reprint R-6116 which describes instruments in the pesticides field and explains how a wide variety of precision scientific instruments aids research and the successful application of chemicals in agriculture. The article is reprint from "Agricultural and Food Chemistry," by F. A. Gunther and R. B. March.

(For more facts circle No. 53 on reply card)

Closed Die Forgings

Pittsburgh Forgings Co. — A 12-page booklet entitled, "Standard Practices and Tolerances for Impression Die Forgings," containing pertinent facts on closed die forgings. This booklet describes forging characteristics, forgeable metals, commercial forging practice and forging tolerances.

(For more facts circle No. 54 on reply card)

Watershed Program

International Harvester Co. — Facts about the watershed program advocated by the Soil Conservation Service of the U.S. Department of Agriculture are contained in a 16-page booklet called Blueprint for Opportunity Unlimited. Methods for preventing floods, protecting land, improving drainage and holding water are discussed.

(For more facts circle No. 55 on reply card)

Pole Barn

Stran-Steel Corp.— This brochure illustrates and describes all-steel pole barns in different sizes for a full range of uses. It lists such features as adjustable telescoping columns, caisson-type concrete column supports, easy to assemble frame, rugged structural members, weathertight sheet fasteners, full range of doors and no-draft windows, weathertight endwall eaves, and wide, long wall and roof panels. "How-to-do-it-yourself" illustrations are also included.

(For more facts circle No. 56 on reply card)

V-Belts

Goodyear Tire & Rubber Co.— Booklet S-51106 describing the machines and processes used in the production of V-belts. Rubber compounding, preparation of fabric, building steps, curing and finishing are subjects for one-page descriptions of V-belt manufacturing operations.

(For more facts circle No. 57 on reply card)

New Tractor Booklet

Allis-Chalmers Farm Equipment Div.— A 15-page booklet containing illustrations of the new D14 tractor. New features listed are low-line high crop clearance design, riding comfort and operating conveniences, power director with 8 speeds forward and 2 reverse, interchangeable front end styles, 149 cu in. power-crater engine, etc. Dimensions and specifications are also included.

(For more facts circle No. 58 on reply card)

Electric Brakes and Clutches

Warner Electric Brake & Clutch Co. — Catalog WEB 6292 gives facts about electric brakes, clutches and controls for miniature mechanisms or high-torque machine drives.

(For more facts circle No. 59 on reply card)

Milk Dispenser Tubes

Gates Rubber Co. — This brochure describes the company's line of milk dispenser tubes with a molded seal.

(For more facts circle No. 60 on reply card)

Replacement Parts

Caterpillar Tractor Co. — An 8-page booklet, entitled "Can You Be Sure?" It shows by drawings and cutaways the individual characteristics of pistons, rings, pins and cylinder liners with emphasis on their physical and metallurgical design features.

(For more facts circle No. 61 on reply card)

Tool Room Grinding

The Carborundum Co.— A 24-page brochure on tool room grinding of alloy, high-speed, and die steels. It is said to be designed to be a source book on grinding for tool room men and covers 22 areas in the field with short, factual copy, pictures and charts.

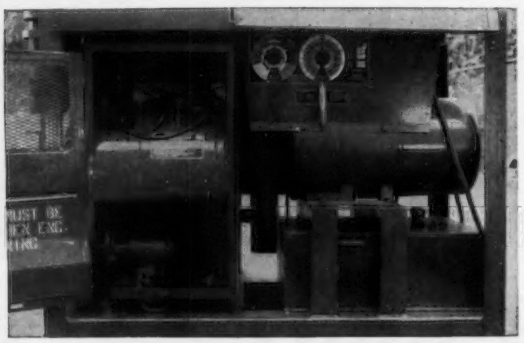
(For more facts circle No. 62 on reply card)

X-Rays on Furnaces

Philips Electronics, Inc.—Reprinted from a national technical magazine, this 4-page folder describes how a company checks furnace batches with X-rays and gets answers in four minutes during the smelting process. Illustrated with drawings, photos and tables, it compares results using old and new methods.

(For more facts circle No. 63 on reply card)

3,143 operating hours *with only minor adjustments with this* 400 *amp.*



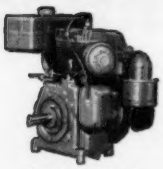
WISCONSIN-POWERED WELDER

On-the-job service is what counts most in an engine. Here, for example, is a brief summary of a service report covering the performance of the Model VR4D 56 hp. Wisconsin Heavy-Duty AIR-COOLED Power Unit which drives the 400 Ampere Arc Welder illustrated above:

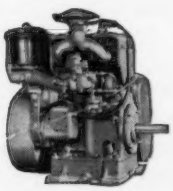
"Has operated exceedingly well . . . approximately 3143 operating hours . . . maintenance has been negligible after a few minor adjustments; appreciate fact that servicing is so simple; we are free of anti-freeze . . . no fooling with gadgets of water-cooled engines."

This is another typical case of outstanding service delivered by Wisconsin Heavy-Duty Air-Cooled Engines on many kinds of equipment. Basic load-holding High Torque, heavy-duty design and construction in all details, foolproof all-weather Air-Cooling and *exclusive specialization* in the design and manufacture of AIR-COOLED Engines are some of the factors that are responsible for Wisconsin Engine preference wherever dependable, economical power is required in a 3 to 56 hp. range.

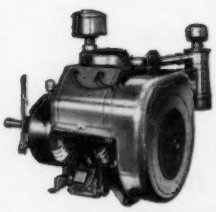
You can't do better than to specify "Wisconsin Power" for your equipment. Write for Wisconsin Engine Bulletin S-212.



4-cycle single cyl. 3 to 12½ hp.



2-cylinder models 10 to 18 hp.



V-type 4-cylinder 15 to 56 hp.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

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TWO GREAT BEARING DEVELOPMENTS ROLLED INTO ONE!

PLYA-SEAL WIDE INNER RING BALL BEARING

Designed expressly for slow speed applications and wet or dirty operating conditions

New Fafnir Plya-Seal Wide Inner Ring Ball Bearings are a combination of two outstanding bearing developments. The most effective seal ever devised for retention of grease and protection against contamination, plus the famous Fafnir self-locking collar, for cost-cutting, twist-of-the-wrist bearing installation. This combination of features offers you several advantages . . .

Best protection yet against dirt, dust, steam, water, lint, other contaminants on slow to moderate speed applications. Contact-type, Plya-Seals seal out abrasive or corrosive material, seal in factory prepacked lubricant.

Less Maintenance — In many applications, non-relubricatable bearings may be used. They require virtually no maintenance time or expense. In other applications, where bearings receive hard or constant use, relubricatable types are available. They require only occasional greasing, even under severe conditions.

Longer Service life — Plya-Seals protect against premature bearing wear or failure. Contaminants cannot damage balls or races; sealed-in lubricant ensures against bearing "running dry".

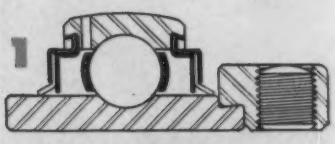
Simplified Designing — Bearing housings may be designed without incorporating separate housing seals. Plya-Seals provide full protection; make possible simplified, less costly, more compact housings.

Power Transmission Units incorporating new Fafnir Plya-Seal Wide Inner Ring Bearing

RAK and RAS Type Pillow Blocks — RCJ Type Flange Cartridges — Fafnir Flangettes

Write for bulletin containing complete specifications on Fafnir Plya-Seal Wide Inner Ring Ball Bearings and Power Transmission Units. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA



1

PLYA-SEALS

As incorporated in the Fafnir Plya-Seal Wide Inner Ring Ball Bearing, the Fafnir Plya-Seal consists of a synthetic rubber-impregnated fabric sealing washer sandwiched between dished steel plates. Seal flares out, maintaining constant contact with ground outside diameter of inner ring. Years of service have proven Plya-Seals the most effective seal ever developed for ball bearings.

2

SELF-LOCKING COLLAR

Originated by Fafnir, this famous development has cut costs and simplified assembly throughout industry. Bearings slip onto shaft; are locked securely with simple twist of self-locking collar. No need for lock nuts, shoulders, sleeves, washers, or adapters. Positive binding action increases with use.

. . . Readers' Forum

(Continued from page 868)

ing the infiltration rate in the ditches. In view of the above requirements, we state on page 106 of our article, second column, first paragraph, under *Desirable slope of feeder ditches*, that, "the ditches should be so designed that they will convey at least twenty times the amount required to satisfy the maximum use of the crop." Optimum operation of an open ditch subirrigation system would include a condition providing for intermittent operation of a single group of ditches.

The limitations of substitution of the slope of the water table for the actual hydraulic gradients occurring in the flow system.

In regard to this problem we interpret Mr. Bouwer to hold, on theoretical grounds, that the equation we propose will not yield an exact solution for all possible conditions varying from infinitely large to infinitely small values for both permeabilities and depths of water-bearing materials. In this, on theoretical grounds, he is correct; however, the conditions he relates where our procedure would result in either, "overdesigned systems" or, "underdesigned systems," should, in actual field work, already have been eliminated from consideration by deductive reasoning based upon criteria such as those enumerated in our article on page 103 under the heading, *Requirements for Subirrigation.*

It should be noted that while most theoretical analyses of flow problems are based upon the assumption of a uniform homogeneous isotropic soil that such fortuitous conditions are seldom, if ever, encountered in the field. One means of simplifying a design problem is the concept of *Coefficient of Transmissibility* where $T = Pb = P_1b_1 + P_2b_2 + P_3b_3$, etc., the sum of the product of permeability of each significant layer times its vertical height. This concept simplifies the preparation and use of design tools such as Fig. 2 on page 106 of our article. If the concept of coefficient of transmissibility T is not used it becomes necessary to plot a family of curves for different permeabilities P relating h to W, and such a plot would have to be repeated for various values of u. Furthermore, it would still be necessary to use the basic concept of coefficient of transmissibility T to arrive at an average value of P for use with the curves.

As Mr. Bouwer suggests on page 202, second column, the theoretical weakness of such an equation, incorporating T can be demonstrated by evaluating W for a hypothetical subirrigation system in solid rock where the permeability is zero but h is very large. However, the answer derived in this case of $W = 0$ agrees with the deduction which could be made by observation without recourse to any equation. We see no reason why a design tool set up for a specific method of irrigation water application should be expected to yield results outside of the range of field conditions where the pertinent method would be applicable. For example, there is no reason why a method for determining the proper length of run under border dike irrigation should be expected to give usable results on land slopes of 15 percent. At this slope the method does not apply anyway and should not be used.

On page 202 of his comments, Mr. Bouwer cites two examples of spacing computations figured for permeabilities of 0.0000068 ft per sec or 0.294 in per hr, and 0.00004 ft per sec or 1.73 in per hr. For the two cases cited, the permeabilities are such that we definitely would not recommend subirrigation in the case of the lesser permeability and we are extremely doubtful if subirrigation would be the best method in the case of the relatively more rapid permeability. About 3 in per hr seems to be the point at which we would recommend a change from surface to subsurface methods of irrigation.

Contradictio in Terminis

We appreciate Mr. Bouwer's remarks concerning the statement, "the Darcy equation of continuity," at the top of page 105, first column. This was in error and it should have been written, "from the Darcy equation."

Conclusion

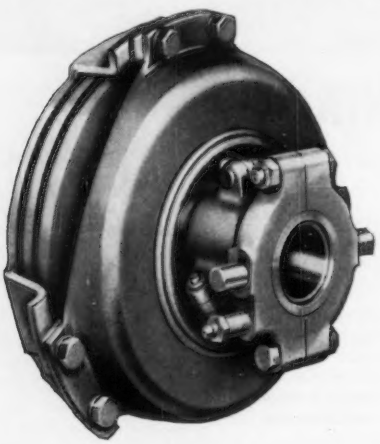
It is our firm opinion that the phreatic lines in a properly designed and operated subirrigation system can and do exist below the bottoms of the feeder ditches. We further feel that the use of the procedure proposed, if employed on areas susceptible to subirrigation by feeder ditches, can safely be utilized for the design of ditch spacings. We have successfully employed it in the investigation and layout of an area of approximately 1,400 acres of land not feasible for irrigation by any other gravity application method.

The existence of more accurate expressions for flow in porous media derived on the basis of hypothetical equipotential lines and the use of higher mathematics is fully recognized. We certainly would not discourage anyone familiar and adept at the use of the more complicated forms from using them. However, field conditions seldom match the hypothetical considerations on

(Continued on page 878)

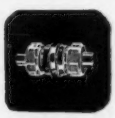
ROCKFORD

Single, Double or Triple Plate CLUTCHES



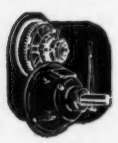
Small Spring Loaded

Heavy Duty Spring Loaded



Oil or Dry Multiple Disc

Heavy Duty Over Center



Power Take-Offs

Speed Reducers

Control POWER Better

The Over-Center, Spring-Loaded clutch shown above—when used in farm tractor LIVE POWER TAKE-OFFS—enables the harvesting unit to be controlled independently of tractor propulsion. It is used in various other ways and in other industries. And it is but one of many types and sizes of ROCKFORD friction CLUTCHES that have been designed and built to meet specific needs. If you have a special power control or power transmission problem, ROCKFORD clutch engineers will be glad to help you solve it.

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Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

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1325 Eighteenth Ave., Rockford, Ill., U.S.A.
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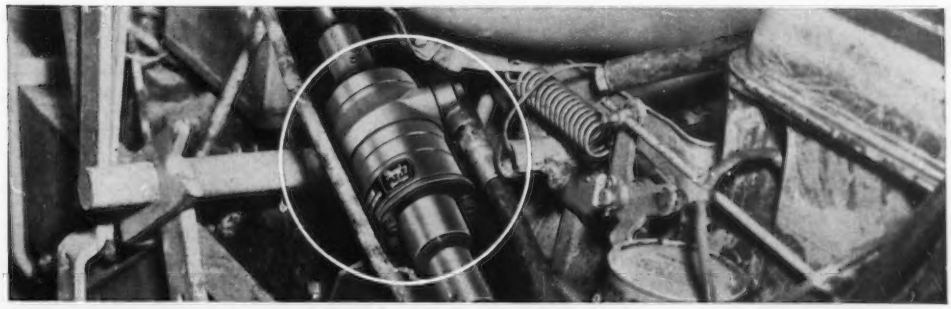
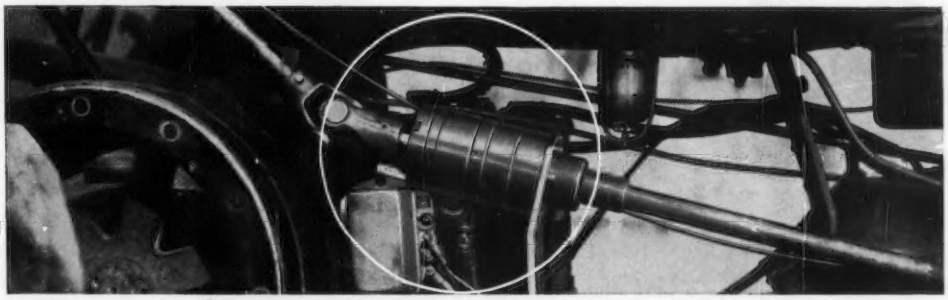
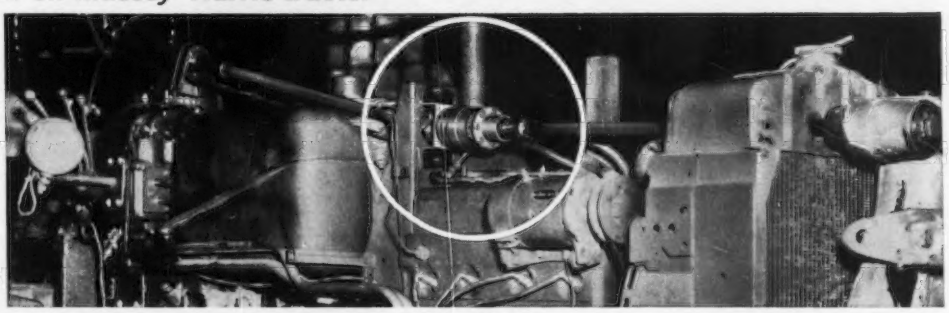
CLUTCHES



Dealer-installed on Allis-Chalmers tractor



Dealer-installed on Massey-Harris tractor



Dealer-installed on International Harvester Tractor

Power steering for tractors... how soon will it be standard?

Dependability of new accessory unit made with nickel alloy steel speeds the day

The Oliver Corporation and the Cockshutt Farm Equipment Company are already installing the Char-Lynn Company's Kontrol-King power steering unit as original equipment on many of their tractors.

Dealers across the country are installing it on several other well-known makes — International Harvester, Allis-Chalmers, Massey-Harris, many more.

Good design and nickel alloy steel provide strength and dependability

The Kontrol-King system is based on a hydraulic motor that develops extremely high torque and transmits it to the tractor steering gear. This component—tested up to 50,000 cycles without showing wear — gets its strength and durability from 6 critical parts of carburized and hardened A.I.S.I. 8620 nickel-chromium-molybdenum steel.

This 8620 develops hard and wear-resistant cases. Responds well to heat treatment. Has the high core strength and toughness to take repeated shock and stress without failure.

Designing . . . buying . . . building new equipment components?

If so, look into the characteristics of nickel alloy steels. For a start, write for the new Inco publication "Nickel-containing Materials in Tractors and Farm Implements." Contains 32-pages of properties, applications and advantages.

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When heavy-duty truck equipment is subjected to terrific poundings, extremely heavy loads, shocks, and stresses—its durability, ruggedness, and ability to "take it" depends on the quality of the components.

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"Foundry Engineered" Unitcastings meet the dimensional accuracy, internal soundness, good surface appearance and other requirements specified by the customer. In addition, Unitcast's modern steel casting methods and facilities make possible the *consistent uniformity* that means a *lower end cost!*

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Unitcast

SPECIFICATION STEEL CASTINGS

. . . Readers' Forum

(Continued from page 876)

which such formulas are based. Considering the fact that we cannot yet accurately measure all of the physical factors required to permit an exact solution (and we doubt if an exact method of solution has been yet developed and with the limited range of conditions under which we would recommend subirrigation, we feel that the method proposed in the subject paper is a practical method to use for design purposes. Without doubt, others will refine this method or develop new ones, but that is progress! We expect and welcome this development.

We appreciate Mr. Bouwer's interest and comments regarding the article. Our correspondence with him on the subject has been enjoyable and very much worthwhile.

ROY L. FOX
JOHN T. PHELAN
WAYNE D. CRIDDLE

EVENTS CALENDAR

January 30-31 — *College-Industry Conference* of the American Society for Engineering Education will be held at the University of Michigan, Ann Arbor, Mich. The theme is on new concepts in the education and development of technical manpower. For more information write to Harold M. Dent, chairman, Subcommittee on Invitations, General Motors Institute, Flint, Mich.

February 3-5 — Association of Southern Agricultural Workers, Marion Hotel, Little Rock, Ark.

February 9-15 — Observance of *National Electrical Week.* The objective will be to create a nationwide spotlight on the contributions of electricity and the electrical industry to our American economy and way of life.

February 13-15 — Meeting of the National Society of Professional Engineers will be held at Michigan State University, East Lansing.

February 16-22 — *1958 National Engineers' Week* sponsored by the National Society of Professional Engineers.

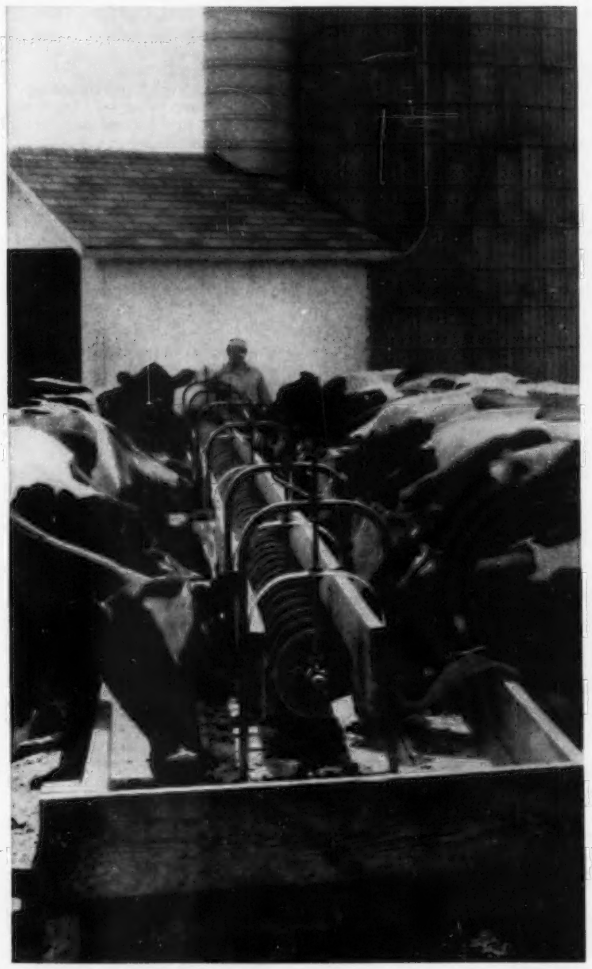
February 25-26 — Sixth Annual *National Dairy Engineering Conference,* Kellogg Center, Michigan State University, East Lansing. Sponsored by the agricultural engineering and dairy departments. For more details write Carl W. Hall, Agricultural Engineering Dept., Michigan State University, East Lansing.

March 16-21 — *1958 Nuclear Congress* will be held at the Chicago Amphitheatre, Chicago, Ill. It is managed by the American Institute of Chemical Engineers and coordinated by the Engineers Joint Council and will include the 4th Nuclear Engineering and Science Conference, 4th International Atomic Exposition, 6th Atomic Energy in Industry Conference, 6th Hot Laboratories and Equipment Conference, and the American Power Conference. For further information write to Engineers Joint Council, 29 West 39th St., New York 18, N. Y.

April 11-18 — *Fifteenth International Horticultural Congress,* Nice, France, on the Cote d'Azur. The theme will be on science in the service of horticultural techniques.

Five "extra" reasons why farm machine designers

specify LINK-BELT augers



LUNCH TIME FOR COWS is no longer chore time for farmers. Here's one example of how Link-Belt augers help to mechanize farm operations. On this Badger Northland Inc. (Kaukauna, Wis.) bunk feeder Link-Belt augers convey feed from silo to feed trough —saves time, money, labor, and unnecessary loss of silage.

FROM selection of materials through final packing for shipment — special controls over the manufacture of Link-Belt augers provide the long-lived performance so vital to efficient operation of your machine. That's why leading designers of farm equipment rely on these Link-Belt engineering and manufacturing extras to protect the good name of their products.

1 STEELS MEET RIGID SPECIFICATIONS

Only selected steels are used—assuring a uniform, smooth, accurately rolled product.

2 CONTROLLED UNIFORMITY OF PITCH

Specialized, modern machinery assures accurate forming to produce uniform flighting consistently.

3 ONE-PIECE, CONTINUOUS FLIGHTING

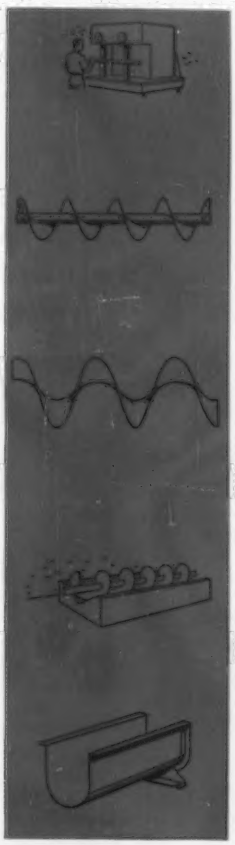
One-piece HELICOID flighting has greater smoothness and strength. Link-Belt also builds many different types to meet your special needs—cut flight, short pitch, ribbon flight, double flight and many other designs.

4 STRAIGHTNESS

Straightness of completed auger is carefully checked before shipping assemblies. Extra care is taken in handling and loading.

5 FULL LINE OF COMPONENTS

Every component can be supplied by Link-Belt, specially engineered for your requirements. This includes troughs, spouts, hangers, screws and drives.



Typical LINK-BELT augers

FOR COMPLETE INFORMATION on these and many other extras you get with Link-Belt augers, contact your nearby Link-Belt office. Or write for 92-page Book 2289 containing full selection data.

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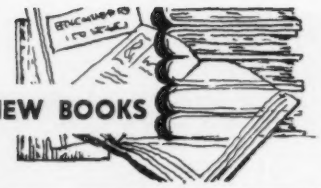
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,746

For more facts circle No. 17 on reply card



Machines for Power Farming, by Archie A. Stone and Harold E. Gulvin. Cloth, 5½ x 8½ inches, illustrated and indexed. Published by John Wiley & Sons, Inc., New York, N.Y. $5.95.

This book combines tractor information with machinery information. The close and essential relation of the machine and its power is emphasized. The authors provide general information on each major machine; instructions for operation and field adjustments; maintenance and upkeep; and selection, management, and economics of use. They cover the basic and most essential machines of modern agriculture. Besides information on the latest machinery the book also gives a brief historical paragraph on each machine.

Tractors and Crawlers, by Irving Frazee and Philip V. Eshelman. Cloth, 5½ x 8½ inches, xi+308 pages, indexed and illustrated. Published by the American Technical Society, 848 E. 58th St., Chicago 37, Ill. $7.50.

This book was written as a training plan to provide the broad knowledge of principles necessary to the selection, maintenance, and repair of the modern tractor and crawler. It is designed for the agricultural student, or anyone who uses or plans to use tractors or crawlers. Industrial workers, farmers, mechanics or anyone concerned in any way with the selection and use of tractors and crawlers should find this book useful.

Design and construction features are covered. Chapters are included on suspensions and steering, engines and accessories, power trains, brakes, and hydraulic systems of many major types of tractors and crawlers now in use.

Thermal Stresses, by B. E. Gatewood. Cloth, 6 x 9 inches, illustrated and indexed, xv + 232 pages. McGraw-Hill Book Co., Inc., New York, N. Y. $7.50.

It is reported that this is the first book in thermal stresses to cover all phases of the design problem at elevated temperatures. The book is for engineers and aeronautical engineers in particular. The emphasis of the material is on fundamental theory and the treatment is applicable to many types of machines other than aircraft; nuclear reactors, rocket motors, steam and gas turbines and their design, and guided missile air frames.

Phases of the analysis and design of structures at elevated temperatures are covered, including temperature distribution, elastic and inelastic thermal stresses, combined applied and thermal stresses, allowable stresses of various materials at elevated temperatures, and the buckling, deflection, stiffness, fatigue, shock, and flutter effects of elevated temperatures. The most recent advances in the fields of thermal stresses, temperature distributions, and material properties are included.

International Directory of Agricultural Engineering Institutions, prepared by H. J. Hopfen. Published by the Food and Agricultural Organization of the United Nations, Rome, Italy, August, 1957. Copies may be obtained from the Columbia University Press, International Documents Service, 2960 Broadway, New York 27, N. Y. Price $1.00.

This edition gives information on research, training facilities, governmental central services in 74 countries of the world, in the field of farm power and machinery, rural electrification, engineering in land development, irrigation and drainage, farm buildings and farm work organization..

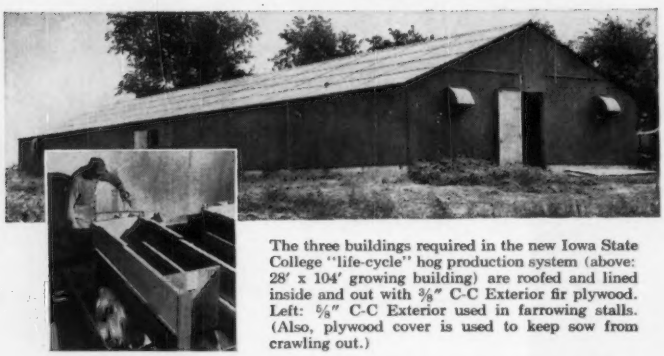
The directory is divided into two parts. The first part contains the names and addresses of central governmental services and of national and international institutes of agricultural engineering and their staff with reference to the type of activity and special work in progress, recent publications issued, and languages which may be used for correspondence. This information is given for each country in the language chosen by the respective Government for correspondence with FAO. The second part lists the national associations of farm equipment manufacturers and distributors, meetings and shows, periodicals, recent textbooks and films concerning agricultural engineering subject matters. A subject index and an index of names are also included.

Atomic Energy and Agriculture, edited by C. L. Comar. Cloth, 6 x 9 inches, x + 450 pages, illustrated and indexed. Publication No. 49 of the American Association for the Advancement of Science, Washington, D.C. Regular $9.50. Prepaid to AAAS members $8.25.

This is a symposium presented December, 1955, at the Atlanta meeting of the American Association for the Advancement of Science and co-sponsored by the Oak Ridge Institute of nuclear studies, under contract with the U.S. Atomic Energy Commission.

Meaningful contributions of atomic energy to agriculture can come about only as the agricultural scientist learns to recognize and apply the research advantages within his reach. In this symposium emphasis has been placed upon critical evaluation of past accomplishments to serve as a basis for the future approach. The subject matter of this volume has been directed mainly toward the contributions of atomic energy to the arts and technology of agriculture in a generally fundamental procedure. It discusses soil-plant relations, various aspects of plant metabolism, a direct application to crop improvement based on response of the biological system to ionizing radiation, and the feasibility of food preservation by irradiation.

Exterior FIR PLYWOOD selected to cut costs on new "Life-Cycle" hog buildings!



The three buildings required in the new Iowa State College "life-cycle" hog production system (above: 28′ x 104′ growing building) are roofed and lined inside and out with ⅜" C-C Exterior fir plywood. Left: ⅝" C-C Exterior used in farrowing stalls. (Also, plywood cover is used to keep sow from crawling out.)

"Fir plywood saved labor, made buildings less costly," says Max Bailey. "Big panels reduce joints, cut heat loss and drafts, and make cleaning easier."

HERE'S proof of fir plywood's advantages. Max Bailey, Story County, Iowa, selected C-C Exterior fir plywood to construct all three buildings required in the new Iowa State College "life-cycle" hog production system. Exterior fir plywood cuts costs, permits tighter construction, reduces maintenance. See your lumber dealer for C-C Exterior fir plywood–the economical panel with 100% waterproof marine-type glue, for permanent exposure to weather or water. *Be sure it's marked C-C EXTERIOR.*

C-C EXTERIOR FIR PLYWOOD DFPA TESTED QUALITY

FREE!

New illustrated booklet explaining "life-cycle" hog production system, with full information on fir plywood for farm buildings.

DOUGLAS FIR PLYWOOD ASSOCIATION
Tacoma 2, Wash. Dept. 305 (GOOD USA ONLY)
Please send me free booklet on "life-cycle" hog production system, and information on available plans.

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AGRICULTURAL MACHINERY NEWS

LATEST PROPERTY AND APPLICATION DATA ON

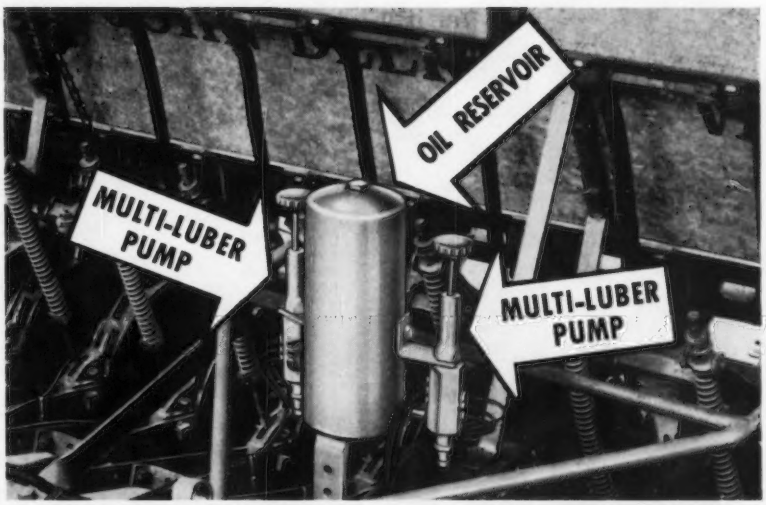
ZYTEL® nylon resin

Strong, flexible tubing of ZYTEL® nylon resin provides long life in lubrication systems

An installation adaptable to many agricultural and industrial machines, automobiles and trucks is the Lincoln Engineering Company's Push Button Power Lubrication System. Flexible tubing of ZYTEL nylon resin makes it possible to handle the lubricants reliably, over long periods of time, at reasonable cost. Either manual or automatic power lubrication is possible with this system.

Tubing of ZYTEL is extremely tough, resilient and abrasion-resistant. It can withstand blows which often damage metal lines. Recommended for low-pressure hydraulic lines, it has burst strength adequate to overcome hydraulic surges. Tubing of ZYTEL is light in weight—about 1/7 the weight of copper and less than 1/2 the weight of aluminum. Tubing of ZYTEL can handle petroleum oils and greases, hydrocarbon fuels, common solvents, alkalies, dilute mineral acids and most organic acids.

For more information about the applications and formulations of ZYTEL nylon resin, mail the coupon.

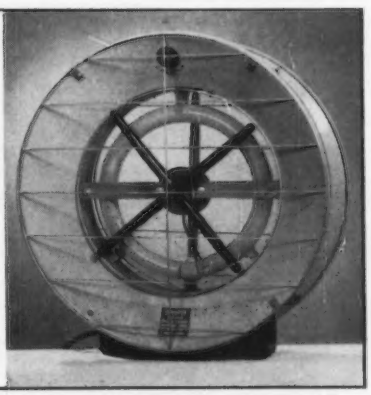


PUSH-BUTTON LUBRICATION SYSTEM for John Deere grain drills depends on flexible tubing of ZYTEL nylon resin to carry lubricant to the disc bearings. Tubing is unaffected by oil and grease. ("Multi-Luber" equipment by Lincoln Engineering Co., St. Louis, Missouri; used on grain drills manufactured by John Deere Van Brunt Company, Horicon, Wisconsin.

"Bug-basher" blade of ZYTEL® helps reduce crop damage

A 4-bladed molding of ZYTEL nylon resin used with a "black-light" lamp kills night-flying pests such as moths, mosquitos and adult forms of tobacco, corn and tomato worms. The blade of ZYTEL is light in weight and is unaffected by insect body chemicals. The manufacturer reports that tobacco farmers claim a "Holliday Bug Lite" every five acres makes spraying unnecessary.

"Holliday Bug Lite" is manufactured by Southeastern Engineering Corporation, Goldsboro, North Carolina.



TUBING OF ZYTEL leads from the "Multi-Luber" pump, mounted on steering column of farm tractor, to the bearings. This equipment affords fast lubrication while unit is operating.

SEND FOR INFORMATION

Mail this coupon for additional property and application data on Du Pont ZYTEL nylon resin.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 112, Du Pont Building, Wilmington 98, Delaware
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I am interested in evaluating this material for_____

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DIVIDED WHEELS
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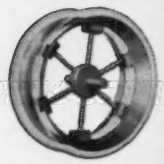
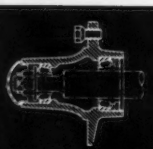
FOR TRUCK TIRES
Full drop center rim to utilize used truck tires on larger implements

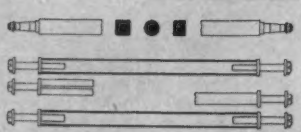


PLANTER WHEELS
Steel rim or for use with planter rubber tires

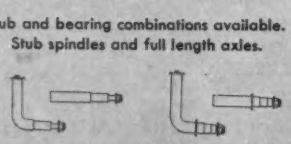
SIX BOLT SERIES
Light and heavy—widest range of implement use



Four bolt series for light implements



Hub and bearing combinations available.
Stub spindles and full length axles.



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Following are brief reviews of papers presented at ASAE meetings or other agricultural engineering papers of which complete copies are available. Information concerning copies of these papers may be obtained by writing to the American Society of Agricultural Engineers, St. Joseph, Michigan.

Dimensionless Storage-Indication Curves for Damsites, by Edwin S. Alling, civil engineer, SCS, and associate professor of civil engineering, University of New Hampshire, Durham. Paper presented at the North Atlantic Section Meeting of ASAE at the University of Delaware, August, 1957. Paper No. **57-36.**

A generalized dimensionless storage-indication curve is presented in this paper which allows the prediction of quantitative storage behind a dam with sufficient accuracy for preliminary planning and design computations. This prediction is said to be accomplished in a fraction of the time normally required to obtain and compute data for an actual stage-storage curve. Use of the curve and method presented should result in a considerable saving in money expended on preliminary investigations, as well as in acceleration of the planning process.

The short-cut surveys required for the method's use in the planning stage are described and limitations noted. The dimensionless curve is intended for use primarily during planning. However, it is stated that it has possible applications in the design phase of operations; for example, as a guide in selecting from the point of view of storage the most efficient dam centerline location.

Upstream Watershed Improvement, by George R. Phillips, chief, River Basins Branch, SCS, USDA, Washington, D.C. Paper presented at the Golden Anniversary Meeting of ASAE in East Lansing, Mich., June, 1957, on a special program arranged by the Soil and Water Division for Public Lands and Public Works. Paper No. **PL-18.**

The paper reports that water's controlling influence upon interrelated soil, water, plant and wildlife problems, aggravated by ever-increasing human population pressure and competition for the use of limited resources, require that they be dealt with to an increasing degree on a watershed-wide basis if there is to be room for adequate agriculture and forestry, industry and commerce, urban living and outdoor recreation. Watershed improvement is discussed as it takes into account the human, animal, vegetative and engineering aspects of soil and water management. It deals with the small watershed as a unit.

A watershed is explained and it is pointed out that the geography is only one component of any watershed for purposes of watershed improvement. Some other essential watershed elements include the trees or grass growing on the watershed, and the crops grown on the land in cultivation; also the way the land is used for farming, grazing, tree growing, recreation and wildlife, and for industrial and other urban use.

The Watershed Protection and Flood Prevention Act is discussed.

Drainage Progress Through the Years, by Virgil Overholt, consultant to the Hancock Brick and Tile Co., and professor emeritus, agricultural engineering dept., Ohio State University. Paper presented at the Golden Anniversary Meeting of ASAE in East Lansing, Mich., June, 1957, on a program arranged by the Soil and Water Division. Paper No. **57-84.**

This paper reports on the role drainage has played in changing the northwestern quarter of Ohio from a mosquito infested swamp, devoid of permanent human habitation, to the highest producing area in the state.

Early types of draintile are described and methods of quality improvement by de-airing the clay, processing the raw material, better temperature control in the kiln, and testing are pointed out. Progress in drainage laws is also discussed. Non-agricultural drainage is reported to have used 30 percent of draintile production during the past year.

A Bigger Job for Engineers in Conservation, by Donald A. Williams, administrator, SCS, USDA. Paper presented at the Golden Anniversary Meeting of ASAE in East Lansing, Mich., June, 1957, on a special program arranged by the Soil and Water Division for Public Lands and Public Works. Paper No. **57-100.**

The paper reports that soil and water conservation is one of the most basic and compensating fields open to trained engineers today. There is especial awareness of the pressing need for water conservation and management as agricultural, municipal, industrial and recreational demands upon this vital resource increase. There has been a development of a clear-cut "conservation engineering" technology, in which the engineer's techniques are integrated with those of other technicians on the complete soil and water conservation job.

Conservation engineering works and land treatment go together. The author discusses the opportunity for the agricultural colleges and universities to offer even more courses in the fundamentals of engineering as it relates to soil and water conservation.

New Methods for Handling and Storage of Loose Hay, by Walter W. Wolfe, chief engineer, The Farmhand Co., Hopkins, Minn. Paper presented at the Golden Anniversary Meeting of ASAE in East Lansing, Mich., June, 1957, on a program arranged by the Farm Structures Division. Paper No. **57-74.**

The paper is divided into five parts covering the handling of loose hay in the field, moving hay to the storage area, placing loose hay in storage, storage of loose hay, and the feeding of loose hay. The author points out that some of the methods used are at least 10 to 12 years old, yet others have not been fully developed.

Advantages are listed which show that with stack movers, use of loose hay will be making a comeback over baling. To name a few of these advantages: labor would be reduced 50 to 75 percent, haying and feeding can be completely mechanized with large capacity equipment, no wire or twine to buy, avoids repeated handling in small units, and better weathering than in bales.

In the handling and storage of loose hay two areas provide a large field for future development work — the storage structure, and the feeding of loose hay. Since the equipment used for feeding loose hay will depend on the structure used for storage of the hay, and the layout of the feeding area, and structures used to house the livestock, a major portion of future development lies in the structures field.

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Utilizing a discarded truck differential, the peanut shaker shown here does the work of four men on the Spann and West farm near Dothan, Ala. In one operation it picks up the peanuts, shakes out clinging dirt and piles them in windrows. Left to right are T. J. Brooks, overseer A. D. Hatton and Texaco Consignee I. H. Hanahan.

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5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
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5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
9	19	29	39	49	59	69	79	89	99

Mow Hay Drying, by F. W. Duffee, H. D. Bruhn, and O. I. Berge, Agricultural Experiment Station, University of Wisconsin, Madison. Bulletin 505, revised June, 1957.

This 19-page publication is illustrated and contains tables on various methods of handling hay from windrow to storage, density of field cured chopped hay and density of barn chopped hay. It reports that mow hay drying has become an accepted practice in the major hay producing regions of the United States. The drying process is explained with discussions on placing the forage in the mow, the air flow, the fan, using waste heat, installation standards for an internal combustion engine operating a mow hay curing fan, and the types of portable drying units available. Sections on the building of the mow drying system, with construction details, different types of the system, and adjustments for varying conditions, are included.

Cost of Owning and Operating Tractors, by John Strait and D. W. Bates. Fact Sheet No. 6. Available from county agent's office or by writing to the Agricultural Bulletin Room, Institute of Agriculture, University of Minnesota, St. Paul 1, Minn.

A method for calculating the cost of owning and operating tractors using different types of fuel is explained by the authors. In order to make the system workable, the researchers made several initial assumptions based on fair state-wide averages. Separate assumptions are suggested for gasoline, propane and diesel powered tractors, enabling farmers to compare the three fuels. Advantages and disadvantages of each fuel type which are not reflected in the cost analysis are also included.

How You, Too, Can Farm Better Electrically, published by the Farm Better Electrically Program, 420 Lexington Ave., New York 17, N. Y.

This booket, FBE-5705, has been prepared to show by illustration and description some of the uses of electricity which are proving of real value to farmers all over America. It includes sections on electrical uses for every farm, electricity on the modern dairy farm, how the poultry man profits electrically, crop processing with electricity, adding livestock dollars electrically, how electricity helps the market gardener, electricity for the fruit grower, every farmer needs an electric workshop, and good electric wiring for the modern farm. Price 35 cents.

A 4-page folder called You Can Help the Farmers of America to Farm Better Electrically lists other materials to tell the story in local rural service areas. These materials include the following: FBE-5704, A Program of Progress for the Farmers of America; promotional materials such as stickers, and decals of various sizes; a booklet on planned farm ventilation, FBE-V-5706; and a farm ventilation display kit. Information concerning the prices of these materials may be obtained from the above address.

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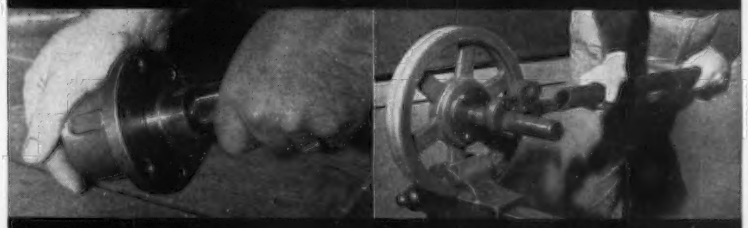

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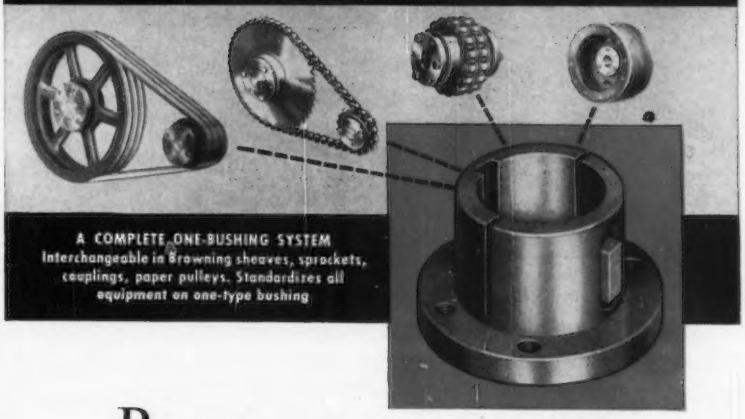

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PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listings.

POSITIONS OPEN—JUNE—O-189-729, 170-730. AUGUST—O-183-734, 196-735, 248-736, 255-737, 259-738, 265-739. SEPTEMBER — O-267-741, 267-742, 267-743, 267-744, 281-745, 292-746, 264-747, 264-748. OCTOBER—O-272-749, 334-750, 334-751, 339-752, 339-753, 336-754, 314-755. NOVEMBER—O-350-756, 350-757, 360-758, 369-759, 362-760, 379-761, 380-762.

POSITIONS WANTED—JUNE—W-186-11, 171-12, 180-13, 190-14. JULY—W-193-15, 192-16, 238-17. AUGUST — W-206-18, 254-22, 239-23, 256-25, 261-26. SEPTEMBER—W-278-27, 276-28, 262-29, 286-32, 299-33, 290-34. OCTOBER—W-289-35, 326-36, 335-37, 331-38, 340-39, 341-40, 301-41, 297-42. NOVEMBER — W-337-43, 320-44, 344-45, 346-47, 357-48, 342-49, 291-50, 363-51.

NEW POSITIONS OPEN

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INSTRUCTORSHIPS in agricultural engineering (half-time basis) for experience and financial support of graduate study, in an eastern land grant university. No age restrictions. BS degree in engineering or in any of the technology fields of agriculture. Salary $2535. O-386-764

AGRICULTURAL ENGINEER for teaching and research in any phase of agricultural engineering in Puerto Rico. Age, under 45. MS or PhD in agricultural engineering. Usual qualifications for college teaching and research. Some teaching and/or research experience preferred. Knowledge of Spanish not essential, but interest in the language desirable. Good opportunity for advancement. Salary open. O-387-765

AGRICULTURAL ENGINEER for senior testing engineer in a new farm equipment testing station in Canada. BS degree in agricultural engineering. Several years experience in agricultural engineering research and testing. Able to handle and supervise research. Must qualify for membership in Saskatchewan Association of Professional Engineers. Excellent opportunity in a new program. Salary $459-555 per mo. O-412-766

PRODUCT DESIGN ENGINEER for design and prototype development of institutional type mowing machines with established manufacturer in upper Midwest. Age 26-40. BSAE or equivalent. Design experience in metal manufacturing industry, preferably in power implements. Alert, stable individual desired. Opportunity up to individual. Excellent working conditions, health and welfare plans, and profit sharing. Salary $6600. O-370-767

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for sales, sales development, promotion or service work in power and machinery or farm structures, with industry or public service, preferably in Southeast. Married. Age, 33. Vision corrected by glasses. BSAE, 1947, Alabama Polytechnic Institute. Experience one year in contract land clearing and earth moving; 3 years as farm manager; 7 years pilot training. War enlisted and commissioned service in Army Air Corps, 2½ years. Available on 45 days notice. Salary open. W-371-52

AGRICULTURAL ENGINEER for development or research in power and machinery or soil and water with industry or public service, anywhere in USA. Married. Age 27. No disability. BSAE 1953, University of Missouri. Farm background. Design engineering in aircraft industry. Commissioned experience USAF as instructor pilot and flight commander. Available on reasonable notice. Salary open. W-378-53

AGRICULTURAL ENGINEER for design, development, or research in power and machinery with manufacturer in USA, Canada, or South America. Married. Age 31. No disability. PSAE 1952, Michigan State University. Design and research engineer on engine development 2½ years. Service experience in USAF as mechanic 3 years. Available on 30 days notice. Salary open. W-394-54

AGRICULTURAL ENGINEER for design, development, research, extension, or teaching, with public service or manufacturer, anywhere in USA. Single. No disability. BSAE 1952, National Taiwan University. MSAE 1956, Kansas State College. Assistant design engineer on farm equipment one year; auto mechanics instructor, 6 mos. Graduate research assistant, 1½ year. Available on reasonable notice. Salary open. W-405-55

AGRICULTURAL ENGINEER for design and development of agricultural machinery with manufacturer, anywhere in USA. Married. Age 30. No disability. BSAE 1950, University of Minnesota. Farm background. Design engineer 3½ years in research and development of grain and corn harvesting machinery with large manufacturer. Sales engineer 3 years with water supply equipment distributor. USNR 14 mos, as trainee in aviation electronics. Available on reasonable notice. Salary $575-625 per mo. W-409-56

AGRICULTURAL ENGINEER for design, development, or research in soil and water field with distributor, consultant, or farming operation, preferably outside U.S.A. Married. Age 34. No disability. BSA, 1949, MSA, 1951, BSAE expected March 1958. Farm background, including fruit farm management. Hydrographer on drainage research project 1½ years. Amateur photographer. War service in Army Air Force over 2 years. Available March 1958. Salary open. W-447-57

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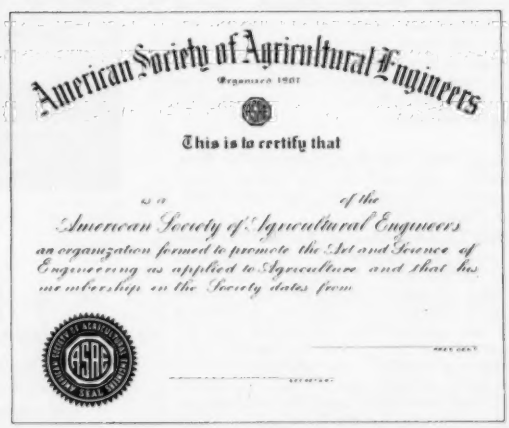
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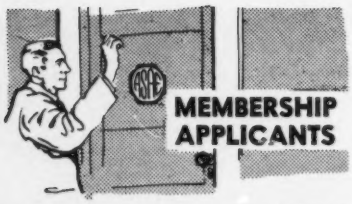

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Aull, James L. — State conservation engr., SCS (Mail) 1743 Graeme Dr., Columbia, S. C.

Barth, Clyde L. — Instr., agr. eng. dept., University of Wisconsin (Mail) 601 S. Orchard, Madison 5, Wis.

Beahm, Robert B.—Grad. teaching assist., agr. eng. dept., Michigan State University (Mail) 1109 B University Village, East Lansing, Mich.

Beck, Theodore H.—Assoc. engr., McDonnell Aircraft Corp. (Mail) 46 Oliver St., Ferguson, Mo.

Bramble, Robert F.—Agr. engr., SCS, USDA (Mail) 211 W. Colorado, Anadarko, Okla.

Braud, Harry J. Jr. — Grad. student, agr. eng. dept., Louisiana State University (Mail) Prairieville, La.

Breckenridge, Charles M. — Sales engr., Dickerson Machinery Co., 230 W. Boone, Spokane, Wash.

Brunner, Robert L. — Des. engr., International Harvester Co., East Moline Works (Mail) 2613 6th Ave., Moline, Ill.

Bryan, Billy—Mgr., Caddo Electric Cooperative, Binger, Okla.

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Davis, James G.—District supervisor, Florida Ford Tractor Co. (Mail) 7943 Orlando Ave., Jacksonville 8, Fla.

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Gerrard, Thomas N. — Works engr., Ivon Watkins Ind., P. O. Box 124, New Plymouth, New Zealand

Gewain, Matthew P.—Mgr. of appliance & dairy dept., Farm Bureau Services, Inc., 4000 N. Grand River Ave., Lansing, Mich.

Godwin, Byron R.—Distributor-owner, Decatur Wonder Building Co., P.O. Box 484, Decatur, Ala.

Gorton, Herman C.—Jr. engr., John Deere Spreader Works (Mail) 5118 8th Ave., Moline, Ill.

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McCraney, Johnny — Div. rural engr., Georgia Power Co., Macon, Ga.

McElroy, Sam M. — Mgr., McElroy Brothers & O'Nan Tile Construction Co. (Mail) R.R. 3, Morganfield, Ky.

McGregor, Frank N. — Elecn. adv. and agr. engr., Cumberland Electric Membership Corp., Clarksville, Tenn.

Maxey, Loren R. — Partner, Maxey Brothers, R.R. 4, P.O. Box 223, Greeley, Colo.

Mohamed, Ibrahim A.—Agr. engr., Ministry of Agriculture, Khartoum, Sudan

Peterson, Seymour—Pres., Storm Industries, Inc., P.O. Box 615, Dassel, Minn.

Rogers, Patrick J. — On duty with U.S. Army, Co. E, 2 Bn. 3tng Reg, Fort Leonard Wood, Mo.

Sawyer, Bobby G. — Engr. in training, John Deere Ottumwa Works (Mail) 743 Camille St., Ottumwa, Iowa

Sherer, J. N.—Records keeper for service dept., Ray Long Equipment, Inc. (Mail) 847 Kilbourne Rd., Columbia, S. C.

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Weeks, O. T. Jr. — Agr. engr., Allis-Chalmers Mfg. Co. (Mail) 1424 W. Waldo, Independence, Mo.

Wharton, Thomas J. — Planning engr., SCS (Mail) 3435 N. Roff, Oklahoma City, Okla.

Williams, Gerald G. — Soil scientist, (ARS, SWCRD) USDA (Mail) Conner Hall, University of Georgia, Athens, Ga.

(Continued on page 892)

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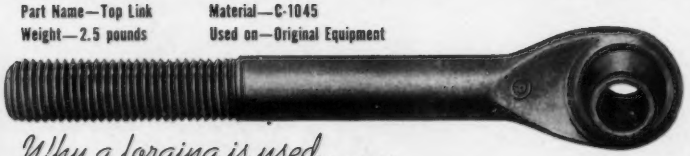
LINK
by
FARM TOOLS DIVISION
PITTSBURGH FORGINGS CO.
1112 THORN STREET
CORAOPOLIS, PENNA.

Part Name—Top Link Material—C-1045
Weight—2.5 pounds Used on—Original Equipment



Why a forging is used.....

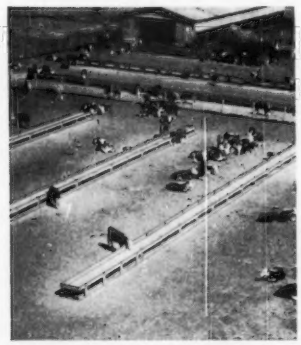
When you take a close look at this Top Link, you realize the forging design knowledge represented in it. For instance, engineering development produces a very close spherical contact between the ball and the link but still the ball moves freely in the socket. Furthermore, production development produces a one piece, no welded top link. Now the part is available without tooling charges as a standard top link.

Original equipment manufacturers can benefit from such forging design knowledge. Just let the forging engineers at Pittsburgh design your problem part forgings.

Help Farmers

reap big dividends from CONCRETE FEED LOTS

Agricultural engineers can prove to their farmer clients that paving feed lots with concrete pays big dividends in feed savings and cattle gains. Read these actual case histories of paved lots.



IN ILLINOIS—

The world's largest concrete feed lot, covering 12.3 acres, is used by the Norris farm for fattening about 6000 head of cattle a year. The paved lot not only saved feed and labor but made possible the recovery of $50,000 worth of manure yearly—which paid its cost in 2½ years.

IN IOWA—

For 60 days Iowa State College fed two groups of steers—one on concrete the other on an unpaved lot. Those on concrete gained an average of 146 lbs. during the test. The "mudders" gained 125 lbs. And steers on concrete actually ate less feed in making greater gains.

IN MICHIGAN—

After battling a muddy yard for 25 years, Clare McLean of Gratiot County paved it with concrete. The paving actually paid for itself the first year. Instead of shipping lightweight cattle in the muddy season, he now goes on feeding them to weights that bring the best prices.

PCA field engineers will gladly help you with concrete feed lot design and construction problems or any concrete farm improvement project.

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33 West Grand Avenue, Chicago 10, Illinois

A national organization to improve and extend the uses of portland cement and concrete through scientific research and engineering field work

Young die-formed tank radiator for use with gasoline or diesel engines.

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These radiators are assembled from precision, die-formed parts. This precision fitting of parts and close unity of assembly provides the strength to withstand the severest jolting over rugged farm terrain.

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If you have a heat transfer problem, contact Young Radiator Company today for the solution. There's no obligation.

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RACINE, WISCONSIN

Creative HEAT TRANSFER ENGINEERS

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

For more facts circle No. 21 on reply card

. . . News

(Continued from page 870)

Fifty Candles to Light the Future Recording

A tape recording of the history of ASAE, entitled "Fifty Candles to Light the Future," has been completed and can be ordered from ASAE Headquarters for $5.50 plus shipping costs. This tape gives both the music and the voice of the person who read the original script at the Golden Anniversary Dinner at East Lansing. The story has been modified and shortened to 29 minutes. This interesting history of the profession should prove helpful in creating further interest in the Society. Mimeographed copies of the script are also available.

Dayton Rubber Overseas Sales

It has been announced that overseas sales for Dayton Rubber products will be handled directly from Dayton, Ohio. Previously, a limited line of Dayton Rubber automotive and industrial products was reportedly handled by a combination export house. The new system is said to enable distributors and representatives throughout the world to deal directly with the manufacturer.

The company's product lines include tires for trucks and passenger cars, hose, V-belts, textile machinery parts, furniture cushioning, printing rollers, lithographic blankets, foam mattresses and pillows as well as other items.

University of Kentucky Curriculum Approved

The curriculum in agricultural engineering at the University of Kentucky has been approved by the course content committee of the Education and Research Division of ASAE, according to a report received from June Roberts, chairman of the division. The institution will be included on future lists of "recognized professional curriculums in agricultural engineering" that are distributed from ASAE headquarters. Twenty-five new students enrolled in the course this fall, which gives a total of 29 students majoring in agricultural engineering. It is hoped that the organization of a Student Branch will soon be completed.

1958 Nuclear Congress Programs

Copies of the advance program for the 1958 Nuclear Congress are available by writing to ASAE headquarters in St. Joseph, Mich. The Congress will be held March 17-21 at the International Amphitheatre in Chicago, Ill.

Developments in atomic energy will be presented from the standpoint of engineers, physicists, metallurgists and chemists. An Atomic Energy Management Conference, designed to provide management with a comprehensive review of the progress that is being made in the development of low-cost nuclear power and other industrial uses of atomic energy, will be a part of the Congress.

RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

W. V. Hukill Honored

William V. Hukill, ASAE Fellow, and a staff member of the AERD of the Agricultural Research Service for 33 years, was presented this fall with a cash award of $300 by the USDA.

The award was based on "outstanding leadership of an engineering program to improve methods, equipment, and structures for storage and related conditioning of grains and seeds on farms."

Mr. Hukill, whose citation and award cover the period from November 1, 1955 through October, 1956, has been stationed at Iowa State College at Ames for several years. He has served at Ames as project leader in research work concerning the conditioning of grain and corn for storage and other purposes.

Recently he was named head of the new grain harvesting and drying section under AERD's Harvesting and Farm Processing Research Branch.

Swedish Nails

Preliminary tests of Swedish nails, designed to reduce splitting and said to have unusual holding qualities, have shown promising results in tests made by AERD engineers. Four vertical flutes, running the full length of the nail, give more holding surface than a heavier common round nail and also increases its lateral resistance. The Swedish counterpart of the American 10d nail yields 94 nails to the pound, while American nails average only 66.

Measures Grain Drying

Advancing the studies of designing an economical grain dryer is the purpose of a recent device developed by AERD engineers at Ames, Ia. The device—a remote humidity-sensing element—makes it possible to observe drying progress through any depth of grain, and thus obtain information essential to many of the basic problems of grain drying.

Fans Cool Beef Animals

Lowering body temperatures of beef animals by use of fans to increase feed efficiency is the purpose of recent tests by AERD engineers in California's Imperial Valley. Results of such tests show that under Imperial Valley conditions air-cooled cattle gained an average of about 2⅓ lb daily, while cattle that were not so cooled averaged only 1½ lb. Furthermore, fanned animals used less feed per unit of gain than did the check group.

Future plans for these studies include continuing work to determine the influence of environment on cattle, swine, and poultry as well as time and travel studies of labor-saving methods and equipment that will increase farm efficiency. One such test offers the possibility of making a single operation of egg gathering and feeding by use of a self-propelled cart.

Another survey includes the study of the operation of 31 egg-producing farms in California. This will be the basis for developing cost-saving improvements in methods and equipment for egg production under California conditions.

. . . Membership Applicants

(Continued from page 890)

Worsley, Gail G. — Supervisor of prod. eng., J. I. Case Co. (Mail) 418 Brown St., Bettendorf, Iowa

Zabcik, Edwin J.—Agr. engr., SCS, USDA, Palestine, Texas

Zervas, Walter O. — Res. engr., American Iron & Steel Inst., 150 E. 42nd St., New York, N. Y.

Transfer of Membership

Bagley, Jay M.—Assist. prof., civil and irrigation eng. dept., Utah State University, Logan, Utah (Associate Member to Member)

Clark, John D.—Advanced designer, International Harvester Co. (Mail) 158 N. Hudson St., Westmont, Ill. (Associate Member to Member)

Garland, John W.—Asst. prof., eng. science dept., Ontario Agricultural College, Guelph, Ontario, Canada (Associate Member to Member)

Gerard, Ernest D.—Assoc. prof. of agr. eng., California State Polytechnic College, San Luis Obispo, Calif. (Associate Member to Member)

Harrell, Edsel A.—Agr. engr., Cotton Ginning Lab., USDA (Mail) P.O. Box 333, Leland, Miss. (Associate Member to Member)

Holmes, Elwyn S.—Asst. res. engr., agr. eng. dept., University of Florida, Gainesville, Fla. (Associate Member to Member)

Hunt, Donnell R.—Asst. prof. of instru. and res., agr. eng. bldg., Iowa State College, Ames, Iowa (Associate Member to Member)

Jedele, Donald G.—Assist. prof., agr. eng. dept., University of Illinois, Urbana, Ill. (Associate Member to Member)

Kirk, William C.—Dir. of farm mechanics, Olds School of Agriculture, Olds, Alta., Canada (Associate Member to Member)

Pallares, Manuel — Supervisor, technical dept., export div., Massey-Harris-Ferguson Co. (Mail) 709 Vaughn Rd., Toronto 10, Ont., Canada (Affiliate to Member)

Palmer, Wayne B.—Zone mgr., New Holland Machine Co. (Mail) 1320 Bennett St., Janesville, Wis. (Affiliate to Member)

Pruitt, William O. Jr.—Asst. res. irrigation engr., irrigation dept., University of California, Davis, Calif. (Associate Member to Member)

Robison, Robert C. — Area engr., SCS, USDA (Mail) 137 N. 11th St., Miamisburg, Ohio (Associate Member to Member)

Shute, Milton — Instr., agr. ind. dept., Southern Illinois University, Carbondale, Ill. (Associate Member to Member)

Snavely, John E. — Farm machinery spec. and assist. chm. of farm machinery and farm structures, agr. eng. dept., College of Agriculture (Mail) American Embassy, USOM, Baghdad, Iraq (Associate Member to Member)

Wales, Thomas E. Jr.—Asst. prof., agr. eng. dept., California State Polytechnic College, San Luis Obispo, Calif. (Associate Member to Member)

the DYNAMIC D17

BIG POWER for BIG FARMING

- *Choice of all-new Allis-Chalmers gasoline or diesel engines — both in the 50-hp class.*
- *Automatic* TRACTION BOOSTER *system. Assures drive-wheel traction equal to that of tractors weighing up to 7,500 pounds.*
- *Exclusive Power Director, with quick shift to high or low range . . . on-the-go.*
- *Eight forward speeds; two reverse.*
- *Constant-speed, live power take-off.*
- *Roll-Shift front axle and Power-Shift drive wheels . . . for quick, easy spacing of all wheels, without use of blocks or jacks.*
- SNAP-COUPLER *hitch . . . for quick mounting or attachment of implements.*
- *Easy-ride seat and low, roomy platform . . . one step, and you're aboard.*
- *Power steering, if desired.*

TRACTION BOOSTER and SNAP-COUPLER are Allis-Chalmers trademarks.

Again, Allis-Chalmers has come forward with another new concept in farm power — the Dynamic D-17 Tractor — that introduces low silhouette, high-crop-clearance design to the heavyweight, 50-hp class . . . plus ability to handle a 5-bottom plow, a 15-ft. tandem disc harrow, and other implements of similar capacity.

With the hydraulic TRACTION BOOSTER system . . . modern method of *automatic* weight transfer introduced by Allis-Chalmers . . . the 5,280-pound D-17* delivers drive-wheel traction equal to that of tractors weighing up to 7,500 pounds.

With a wealth of other advanced features that farmers have said they wanted in a tractor, the D-17 brings greater speed, ease, versatility and economy to the operation of today's larger, more intensively worked farms.

**Weight of gasoline model — diesel tractor pictured weighs 5,680 pounds.*

ALLIS-CHALMERS, FARM EQUIPMENT DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

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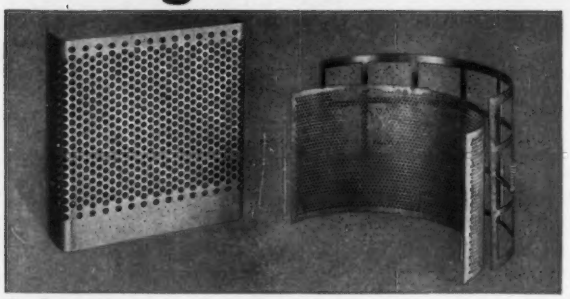
Catalog of Good Ideas!



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British firm of engineers with experience in the manufacture of machines for industrial use, would welcome the opportunity of making, under license, specialty or patented machines for the agricultural industry. Advertisers have had considerable experience in making and marketing engineering products in Great Britain and the principal countries of Europe and the British Commonwealth. Good sales staff are available and there are ample facilities for servicing machines and for looking after maintenance and the supply of spare parts. Firms interested in having machines manufactured under license for British or European markets should write, if possible before December 31. A Director of the Company will be visiting the U.S.A. in the early part of 1958, and will be available for consideration of proposals and preliminary talks during the month of February. LISTER BROTHERS LIMITED, Nightingale Vale, Woolwich, London, S.E. 18, ENGLAND.

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ND FACTS

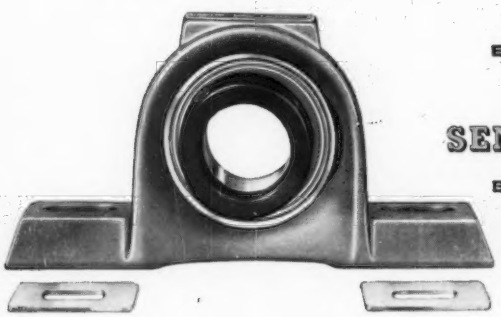
NEW DEPARTURE PILLOW BLOCKS— BUILT FOR LOWEST MAINTENANCE

- New Departure adapter ball bearings are sealed and lubricated for life.
- Design is compact and rigid—fits easily in limited space.
- No grease nipples or other protruding lubricating fixtures needed.
- Pillow blocks are easily mounted without need for any special tools.
- New Departure ball bearings are high capacity, precision-built for long life.
- Bearing and block surfaces are spherical to accommodate any misalignment.
- Thirty-two shaft sizes, $\frac{1}{2}$" through $2\frac{15}{16}$", for wide variety of applications.
- Interchangeable with most other makes of pillow blocks.

Bearings are easily applied to shafting and are positively locked in position with eccentric cam locking collar and set screw.

Elongated bolt holes designed to accommodate practically every type of spacing for hold-down bolts.

Mounting pads are furnished with each New Departure Pillow Block to assure easy interchangeability with all pillow blocks having a high base-to-center dimension.



EQUIPPED WITH

BALL BEARINGS

New Departure Pillow Blocks employ performance-proved Type AE adapter ball bearing with Sentri-Seals for long-life protection against dirt or grease leakage.

Send for Catalog PBC

1908–1958 GM FORWARD FROM FIFTY

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

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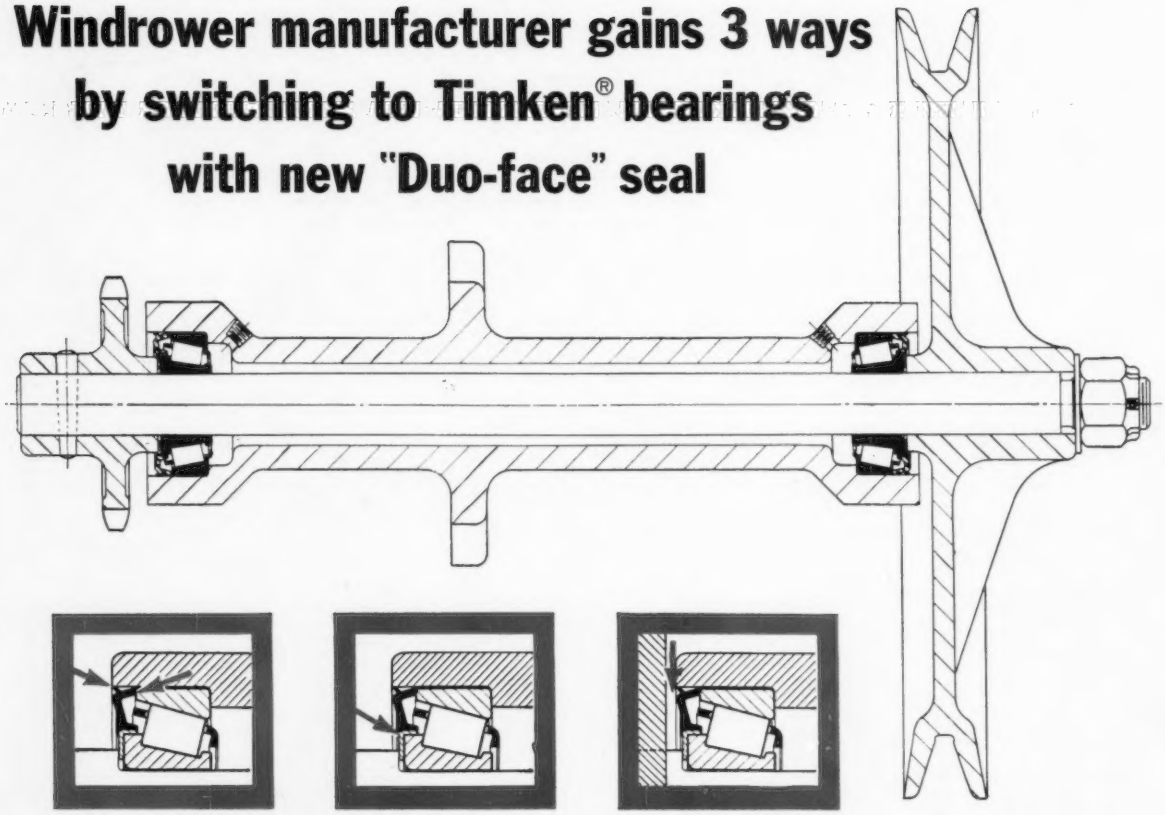
Windrower manufacturer gains 3 ways by switching to Timken® bearings with new "Duo-face" seal



1. Gets 2-way sealing
New Timken bearing Duo-face seal seals against both the bearing cup face and housing bore.

2. Cuts installation costs
Nothing to assemble. Duo-face seal comes pressed on the cone as a unit assembly.

3. Saves space
Seal adds practically nothing to the width of the bearing.

INTRODUCED only four months ago, Timken® bearings with the new "Duo-face" seal are going into more and more farm machines as major implement manufacturers switch to this new bearing-seal unit. The large diagram shows how one manufacturer uses it on the platform drive of a self-propelled windrower. The small diagrams show how he saves three ways.

1. GETS 2-WAY SEALING. The new Duo-face seal is the only anti-friction bearing seal having the combined advantages of an O.D. and a face type seal. One lip operates against the bearing housing bore, providing an O.D. seal. The other against the smooth, flat, hardened surface of the bearing cup, providing a face type seal.

2. CUTS INSTALLATION COSTS. Factory assembly of the seal on the cone ends mounting of the seal and bearing in separate operations. It eliminates special handling and assembly problems. There's no need for special tools or fixtures. No extra installation costs. And there's less chance of damaging the seal when removing it from a machine.

3. SAVES SPACE. Less space is needed for the new Duo-face seal than for conventional seals. This permits more compact hub and housing designs yet does not limit lubricant capacity.

The Timken Company Duo-face seal has been field-tested and proved on self-propelled windrowers, tractor front wheels, implement wheels, disc jointers, disc harrows, coulters, side-delivery hay rakes and conveyor idlers. Timken bearings with assembled Duo-face seals are available in the following bore sizes: .7500″, .8437″, 1.0000″, 1.2500″, 1.3750″, 1.5000″ and 2.6875″. For information, call your nearby Timken Company sales engineer, or write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

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BEARING TAKES RADIAL ▯ AND THRUST →▯← LOADS OR ANY COMBINATION ✳

The farmer's assurance of better design

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